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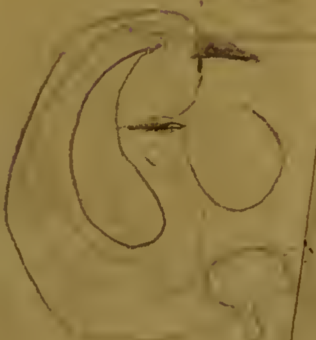

To Mr. James Phelan
with the author's best wishes

Oct. 1875

THE PRACTICAL AND DESCRIPTIVE ANATOMY

OF

THE HUMAN BODY.

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PRACTICAL AND DESCRIPTIVE ANATOMY

OF

THE HUMAN BODY.

BY

THOMAS HAWKESWORTH LEDWICH, F.R.C.S.I.

AND

EDWARD LEDWICH, F.R.C.S.I.

LECTURERS ON HUMAN AND COMPARATIVE ANATOMY, IN THE ORIGINAL [NOW, THE LEDWICH] SCHOOL OF MEDICINE, PETER STREET DUBLIN.

—" humani nihil a me alienum puto."—TER.

Second Edition, revised & enlarged,

BY EDWARD LEDWICH, F.R.C.S.I.

Surgeon to Mercer's Hospital.

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OF THE

ROYAL COLLEGE OF SURGEONS IN IRELAND.

THIS WORK

IS RESPECTFULLY INSCRIBED

BY

THE AUTHORS.

PREFACE TO THE SECOND EDITION.

The first edition of this work having become exhausted, I have been induced to undertake the revision of a second, and it was only when fairly embarked in the undertaking that I became fully aware of the labour of the task I had imposed on myself; for so many and so various were the required alterations, that to have re-written the entire would, perhaps, have been attended with less labour. My great object was, however, to adhere to the general outline of a plan which experience had taught me was attended with many advantages to the student, and to preserve unbroken the link of association under which the whole was produced. And here I most gladly avail myself of the first and only opportunity that has hitherto presented itself, of assigning to each individual the part that he performed in the production of this work.

The articles on the *Muscles*, on *Hernia*, on the *Generative* and *Urinary Organs*, *Perinæum*, *Heart*, *Brain*, *Orbit*, *Eye*, *Skin*, and *Absorbents* were originally written by my late lamented brother, Thomas Hawkesworth Ledwich; *those* on the *Bones*, *Ligaments*, *Chest*, *Abdomen*, *Spinal Marrow*, *Spinal*, *Cerebral*, and *Sympathetic Nerves*, *the Ear*, *Nose*, and the *Arterial* and *Venous Systems*, constituted the part allotted to me. Unfortunately there was no mutual supervision exercised, and hence arose a fertile source of many of those verbal inaccuracies that appeared in the former edition. In the present edition I have most freely availed myself, in correcting the press, of the kind assistance of Robert Travers, M.B. T.C.D., Lecturer on Forensic Medicine, and College Professor of Medical Jurisprudence, on

whose judgment and accuracy, I feel that the most implicit reliance may be placed. In every way that it was possible, I have endeavoured to simplify what must always be a difficult and abstruse subject to the junior student, and I would consider my time and labour well expended should I succeed in winning him back to the subject—the only legitimate field in which a practical knowledge of anatomy can be obtained; for, however faithfully executed the plates may be, the parts which they labour to represent will fade like a dream from the mind, while a single glance at nature, in the original, will impress itself on the senses with enduring pertinacity.

EDWARD LEDWICH.

7, Harcourt-street, Dublin,
November, 1864.

PREFACE TO ORIGINAL EDITION.

In presenting an additional Treatise on Human Anatomy to the Profession, we are fully aware that a certain amount of censure will be incurred for adding another work to the many already existing on a subject which has heretofore been so ably treated by preceding anatomists. But whilst we disclaim being actuated by the mere desire of producing a book, we must admit our belief that the existing class-books might be made more consistent with the wants of the student and profession generally; and with this view a systematic description has been adopted; whilst the discursive style, though more facile of execution, and certainly more beautiful, has been rigidly avoided,—thus allowing a greater amount of anatomical information to be condensed into this, than into any other work of a similar magnitude. The relative anatomy of organs and parts has been also carried out minutely, together with their functions and structure, the descriptions being in conformity with the most recent discoveries on each subject, verified by our own observations and researches. The remarks on the Arteries and Veins have been confined to their practical anatomy only, as the volumes of Power, Harrison, and Corbett render any further observations on the surgical relations of those vessels quite superfluous.

21, York-street, Dublin,
October, 1852.

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ANATOMY OF THE HUMAN BODY.

SECTION I.

THE OSSEOUS SYSTEM.

THE term skeleton has been applied to those denser elements of the animal tissues that, when combined as immoveable plates or jointed segments, constitute either solid shields for the protection of the softer structures, or subserve to the active movements of animals, by supplying the passive organs for attachment of the muscular system. In all the invertebrate class, with the exception of the cephalopoda, the skeleton is found external to the muscles (exo-skeleton); but although many of the vertebrate class retain certain portions of the external skeleton in various grades of development, still its gradual extinction is perceptible in proportion as increasing perfection and symmetry prevail in the internal (endo-skeleton). In many classes this perfection may be evidenced only in reference to particular functions, and symmetry may be sacrificed to such arrangements as confer strength and solidity; or, these again may yield to the mechanical requirements that conduce to rapidity of motion, combined with excessive lightness. But whilst a continual change of the centres of increased development may be observed in the lower orders of vertebrata, producing physical characters in unison with the habits and necessities of the animal, the human skeleton, on the other hand, exhibits a persistent form not constituted for the predominance of any one particular function, but equally well calculated to promote that perfect series of actions which, by harmonizing with the necessities and requirements of the being, impress the characters of an admirable uniformity on all its functions. The asymmetrical condition of the solid framework, with its continual alterations in form and arrangement in the invertebrata, obviously precludes any attempt at a system of nomenclature applicable to the parts of which the skeletons are composed; but in the higher vertebrata the calcareous masses or bones, that by their apposition con-

struct the osseous framework, are so definite in situation, distinct in figure, and regular in size, as to render classification simple, nomenclature attainable, and individual description merely an enumeration of facts.

Bones have been classed into the *long*, *flat*, and *irregular*; of these, the first are extended, as their name implies, and are furnished with a central shaft, and two extremities, twisted in the long axis, and situated in the extremities, where they form the passive elements of levers; the second are thin and flat, composed of two dense or compact plates, with intervening cancellated tissue, expanded so as to form the boundaries of cavities, as the cranium, thorax, and pelvis; while the third are short, thick, and irregular, consisting of a mass of cancellated structure, surrounded by a thin layer of dense bone, and are principally found in those situations where strength, security, and lightness are required, as for instance in the tarsus, carpus, and vertebral column, where by the multiplication of joints, and the consequent distribution of motion over an extensive surface, a comparative immunity from dislocation results. Still a fourth class of bones has been also recognised, which have been termed *sesamoid;* they are small and round, developed in the tendinous structures, and generally placed where, by altering and increasing the angles formed by the insertions of muscles, they tend to augment their motive power.

Nomenclature may be derived either from the situation that bones may occupy, as the frontal, parietal, occipital; or from their shape, as cuneiform, unciform, tibia; or from their size, as os magnum; or from their use, as clavicle, vertebræ, atlas, &c.

With respect to composition, bone structure may be said to consist of a certain animal substance termed gelatine, to which it is indebted for its toughness, elasticity, and pliability, whilst its durability and powers of resistance may be attributed to the number of earthy and calcareous salts with which it is very liberally supplied. The proportion, however, which the animal and earthy constituents bear to each other at different periods of life, vary exceedingly, as may be gathered from the subjoined table of Schryer, on which the utmost reliance may be placed:—

	CHILD.	ADULT.	OLD AGE.
Animal matter, ...	47·20	20·18	12·2
Earthy matter, ...	48·48	74·84	84·1

Or, it may be stated in general terms, that in the child the earthy matter forms nearly one-half of the entire weight of the bone, in the adult it is equal to four-fifths, and in old age it amounts to seven-eighths (*Todd and Bowman's Physiology*).

ANALYSIS OF BONE.

Organic,	Gelatine,	32·17
	Insoluble organic matter,	1·13
Inorganic,	Phosphate of lime,	51·04
	Carbonate of lime,	11·30
	Fluate of lime,	2·10
	Phosphate of magnesia,	1·16
	Soda and chloride of sodium,	1·20

The animal matter or gelatine may be extracted from bones by subjecting them to long-continued boiling in Papin's digester, and when the fluid is removed and allowed to cool, it solidifies, and forms a transparent jelly. This may again be liquefied by heat, and from a dilute solution the animal matter may be precipitated by tannic acid, as tannate of gelatine. The insoluble organic matter consists of the fibrine and albumen, yielded by the coats of the blood-vessels, and any small remains of blood they may contain. The calcareous salts may be removed by digestion in dilute hydrochloric or nitric acids, leaving still a perfect cast of the original bone, exhibiting such slight resistance that it may be twisted into any form. Incineration consumes the animal tissue, which at first becomes black, but when entirely removed, the bone appears white, friable, and light, consisting almost wholly of the insoluble salts or bone earth, of which the subphosphate of lime constitutes the greatest amount.

When a vertical section of a long bone is examined by the unassisted eye, several structures essentially differing in their physical characters may be observed: thus we have the shaft or centre, formed of dense compact tissue, with an apparently fibrous arrangement in the vicinity of the periosteum, but becoming more loose and cancellous towards the medullary surface; while the extremities, surrounded by a thin, compact layer, enclosing the coarse cancelli, contain a semi-fluid, fatty matter, analogous to the contents of the medullary canal. This prevalence of the loose reticulated tissue in the ends of the long bones, increases the surface for articulation without materially augmenting the weight. The flat bones also consist essentially of compact and areolar tissue, the former constituting the surface layer, with the latter interposed as diploe, but occasionally the compact tissue is absent on the surface, when the bones appear cellular and porous, as in the spongy, and portions of the ethmoid. The irregular bones are merely modifications of the flat in structure, the most evident dissimilarity being the greater prevalence of cancellous tissue, with consequent lightness and friability, as exemplified by the bones of the tarsus and carpus; but the latter

properties are not always characteristic, as the petrous portion of the temporal bone, though certainly irregular, combines the greatest amount of density with corresponding resistance.

Microscopic Characters.—A thin, transverse section of a long bone, properly prepared for examination, will exhibit a number of dark, circular, or subcircular openings, larger and more numerous in the vicinity of the medullary cavity (Haversian canals), and surrounded by concentric laminæ, indicated by faint, dark circles, when subjected to a higher power, with feeble illumination. Their number ranges from three to twelve around each canal, and to these we will apply the term secondary laminæ; in their structure may also be observed a second series of dark points, termed the osseous lacunæ, or corpuscles, or as they are sometimes called, calcigerous cells; these in the human bone are semilunar, with the concavity turned towards the Haversian canal, of which they are the satellites; they communicate internally with the Haversian canal by fine pores or transverse canaliculi, and externally with those of the proximate lamina, but neither lacunæ nor canaliculi are visible in the bone tissue of the intertubular spaces. A longitudinal section represents the canals passing parallel with the axis of the shaft, and frequently communicating with each other, and the true figure of the lacunæ may also now be determined, which is that of menisci. The Haversian canals have an average diameter of $\frac{1}{500}$ of an inch; the canaliculi, $\frac{1}{1600}$; and the lacunæ, in their vertical diameter, an average of $\frac{1}{1800}$, usually half as wide, and one-third as thick (Todd and Bowman). The external surface of the bone is surrounded by laminæ proper to its entire thickness; these are from seven to ten in number, and may be well observed in a section which has been macerated in acid for a certain time; these may be called primary laminæ, to distinguish them from those of the Haversian system. The pores of the most superficial lacunæ open on the periosteal surface, and those of the most deep on the medullary; an arrangement that might be fairly anticipated, in consequence of the continuity of all the elements of their anatomical composition.

The ultimate structure of the laminæ is difficult to be determined; with a high power of about 650, the surface seems granular, according to Dr. Sharpey, with small lozenge-shaped spaces, formed by the crossing of minute fibres. We have repeatedly observed these spaces and the so-called fibres well marked in the lachrymal bone, prepared on one side only, so as to be transparent under a high power, and this especially when the light was reflected obliquely. Mr. Tomes conceives the ultimate structure to be formed by minute granules, which may be either oval, oblong, or angular in shape, imbedded in a species of tissue, with characters not yet definite. However, in

the ossifying nucleus of the femur the fibrous arrangement is quite evident, which clearly proves that there certainly does exist a fibro-cellular stage, whether this condition is persistent or otherwise. Connected with the bones there are certain membranes, the external of these being called the periosteal, the internal, the medullary. The periosteum is a dense, fibrous layer, covering and adhering to the entire surface of the bone, except at the articular extremities, where a stratum of cartilage is substituted. At the vascular foramina it sends processes into the bone to line the canals, and thus it becomes continuous with the medullary membrane. It is soft, thick, and vascular in fœtal life, paler in old age, but still decidedly vascular when well injected; its surface gives attachment to muscles, defends the bone from injury, and conduces in a great degree to its development. The medullary membrane, similar in structure to the periosteum, lines the cells and the medullary cavity, and forms a basis in which the vessels ramify. In fœtal life this membrane assists in the formation of the closed medullary cells, but as life advances the canal is formed, conferring on the entire bone the properties of lightness and strength.

Vessels.—These enter by minute foramina in the shaft, and by more numerous openings on the extremities, but one large branch will be found to penetrate at about the centre of each long bone, intended principally for the supply of the medullary membrane, while the veins leave by separate openings, which are larger than those for the arteries. In the cranial bones, Breschet has described venous networks, seen in the diploe, by rasping off the external table of one of the flat bones, as the parietal, but they differ from the other osseal veins in the fact of possessing valves.

Nerves are absent, at least for the supply of the bone tissue; and the existence of lymphatics is doubtful.

Development of Bone.—The first rudiments of the future skeleton appear as opaque spots in the lamina dorsalis, constituting the primary traces of the spinal column. The cartilaginous matrix of the less important bones immediately follows, so that the whole skeleton consists of a hyaline substance, which at the fifth week undergoes subsequent changes, which may be classed into stages, three of which have been recognised, but to which we would be disposed to add a fourth. The first of these, or stage of hyaline mass, more generally called gelatinous, is marked by the existence of a hyaline basis, with scarcely a trace of cell structure visible to give it the character of cartilage. Gradually, however, the appearance of dark points indicates the formation of nuclei and cell-walls, constituting what may be termed the second or cartilaginous stage. The cartilaginous cells now exhibit a disposition to arrange themselves in co-

lumns, with a further tendency to form groups, and at the same time the cells are flattened on their opposed sides, while the nuclei enlarge and sometimes divide. In the centre of the shaft of a long bone, an opaque, transversely oval mass appears, and from its upper and lower surfaces laminæ of a similar nature grow into the intercellular spaces; these send their transverse laminæ across the groups, thus enclosing them in perfect cells, elongated in the axis of the bone, and as these laminæ are distinctly fibrous, this may be considered as the third, or fibro-cellular stage. As, however, the elongation of the laminæ continues, the hyaline is being absorbed, while the cartilage cells increase in number. Within, the cells of the laminæ are also altered; highly refracting points appear, signifying the presence of fatty matter; and as these enlarge, coincident with this increase, the cells attach themselves to the laminar wall of the cancellus which contains them. The fluid of the latter cavity becomes fatty, granular, and of a reddish colour, developing the elements for the endogenous growth of new laminæ, imbedding, of necessity, the cartilage cells, which after some time disappear, but the nuclei remain to form the osseous lacunæ. The absorption of the transverse septa converts the cell-spaces into canals (Haversian), and the radiate prolongations of the nuclei develope the canaliculi, but these nuclei are not persistent, as a coarse earthy material is substituted that occupies the lacunæ in fully developed bone. This is the fourth or ossific stage, in which the assumption of the several calcareous salts obliterates all fibrous arrangement. Ossification commences in the long bones by three centres, one for the shaft, and one for each extremity; and as these gradually extend towards each other, they as gradually encroach on the mass of cartilage that intervenes between them. The extreme points are called epiphyses, the shaft or centre the diaphysis, and it is in the space between them that elongation as to growth occurs, the already ossified portion remaining unaltered, while in a period ranging from the twenty-first to the twenty-fourth year, ossification is completed, any further increase of length being precluded after this time.

In order to prove this fact, Hunter introduced two pellets into the already ossified shaft of the tibia of a young pig, having first accurately measured the distance included between them; he then allowed sufficient time to elapse to allow a decided growth of new bone to take place, when he examined the part, but was unable to discover any appreciable increase as to distance between the pellets. Prominent points are separately developed, and are named apophyses; examples of this description are found in the lesser trochanter, cristæ ilii, and tuberosities of the humerus, where they appear as complementary points of ossification. The long bones in-

crease in thickness concentrically by the deposition of successive layers, developed through the instrumentality of the periosteum, while an eccentric growth is also continually proceeding by the formation of new laminæ within the Haversian canals, produced by their lining membrane. Again, flat bones are developed in radii, diverging from a central osseous nucleus, as may be observed in those of a fœtal cranium: but in these also, epiphyses may be formed at the circumference, as for example on the crest of the ileum and base of the scapula. The irregular bones resemble the flat very remarkably in their mode of development, presenting an osseous central nucleus, which is sometimes double.

The human skeleton is composed of 198 bones, exclusive of the sesamoid, and for the sake of description may be divided into a spinal column, surmounted by the head; thorax, and thoracic extremities; pelvis and pelvic extremities.

THE SPINAL COLUMN.

The spinal column in the human subject has been divided into two parts: an upper portion, comprehending the greater amount of its extent, called the true vertebræ; and a lower, much more limited in its vertical length, termed the false, this appellation having been applied to the sacrum and coccyx, which in early life were separated into numerous pieces by cartilaginous discs, each piece presenting at that period characters sufficiently well marked to entitle them to a designation which they now appear to have received by almost general consent.

The true spine, reaching from the cranium to the base of the sacrum, consists of twenty-four distinct pieces, called vertebræ, firmly united together by cartilage, ligament, and direct articulation; but as the several bones which compose the whole differ from one another in many essential particulars, it has been divided into three regions: above, the cervical vertebræ, embracing the first seven; in the middle, the dorsal, comprehending the twelve succeeding; and below, the lumbar, consisting of the last five. All those several bones, however, possess certain general features which may be said to be common to the whole, as, for example, each presents for consideration a body, forming the entire of the anterior part of the bone, and a series of processes, nine in number, constituting its posterior portion. The processes are known by the following names: two pedicles, springing from the posterior, superior, and lateral parts of the body, and connecting it to the oblique and transverse processes; those processes, short, strong, and rounded, present a shallow groove above, and a deeper notch below, which by the ar-

ticulation of any two corresponding vertebræ, are converted into irregular holes, the foramina of conjugation, through which are transmitted nerves from the spinal marrrow, as well as arteries and veins, the one to supply the structures within the canal, the other to establish a communication between the general and Rachidian venous system. From the posterior extremity of those pedicles, the transverse processes jut out laterally; they are about an inch in length, and present various peculiarities, which will be more properly noticed in the description of each of the several regions. The articular or oblique processes are situated above and below the root of the transverse; they are covered with cartilage of incrustation, and interlock with those of the adjacent vertebræ above and below. From the roots of the transverse and articular processes spring the laminæ, broad plates of bone, taking a direction backwards and inwards, converging so as ultimately to form the spinous process, the last in our enumeration.

Lumbar Region.—A vertebra in this region has the following peculiarities:—A body of an oval shape, longer from side to side than from before backwards; its superior and inferior surfaces concave and rough, and intimately united to the intervertebral cartilaginous discs, which connect it above and below to the corresponding vertebræ; its upper and lower edges are marked by a narrow ring of bone, of hard compact tissue, which confers a certain degree of strength on the otherwise spongy structure of the bone, and gives attachment to the anterior common ligament; the anterior and lateral aspect of the body is concave from above downwards, and convex from side to side, presenting numerous foramina for the entrance of the nutritious vessels, while its posterior surface is slightly concave from side to side, straight from above downwards, exhibiting in its centre a large irregular hole, sometimes double, through which emerges the basi-vertebral vein to open into the tranverse Rachidian vessel, which lies in close contact with the bone, immediately anterior to the posterior common ligament; in vertical depth the front of the body is something greater in extent than that of the back. If we now direct our attention to the upper and outer parts of the back of the body, we will find the pedicles to arise from those points; they take a direction backwards and a little outwards, terminating externally in the transverse, and internally in the superior and inferior articulating processes. Those pedicles are short thick masses of bone, exceedingly strong, lying between the foramina of conjugation, and separating the nerves as they pass out from the spinal cord. From their distal extremity spring the transverse processes, which are thick and strong at their origin, but gradually taper away, and become thin and flattened near their termi-

nation; as they pass outwards they have a very slight inclination backwards, and afford attachment to the lumbar mass of muscles posteriorly, to the middle layer of the transversalis aponeurosis and the quadratus lumborum by their extremities, and to the tendinous arches of the psoas anteriorly. The oblique or articulating processes, situated above and below at the extremities of the pedicles, differ from each other in the surfaces which they present for articulation with those of the contiguous vertebræ—the superior being concave from side to side, straight from above downwards, and looking inwards and backwards, while the inferior are exactly the reverse, being convex from side to side, and looking forwards and outwards; they are covered with cartilage, and present a smooth and polished appearance. The laminæ in this region are broad, and directed obliquely downwards and outwards, diverging anteriorly where they become continuous with the roots of the oblique and transverse processes, and converging posteriorly where they unite to form the spine, while their upper and lower margins are connected to the corresponding vertebræ by elastic tissue, called the ligamenta subflava. The spinous process, passing nearly horizontally backwards, is wedge-shaped, thin superiorly, thick inferiorly, blunted at its extremity, giving attachment to the supraspinous ligaments and lumbar aponeurosis, while to its sides are connected the extensors of the spine. The canal in this region is comparatively large and triangular in shape, bounded in front by the back part of the body; on each side by the pedicles, and roots of the transverse and oblique processes; and behind by the laminæ, converging to form the spine.

The fifth or last lumbar vertebra differs from all the others in the following particulars. It is cut off obliquely on its inferior surface, so that its vertical depth in front far exceeds its similar measurement posteriorly, the same rule prevailing with respect to the intervertebral disc between it and the sacrum, this arrangement producing that remarkable appearance at the junction of those bones, known as the promontory of the sacrum, or sacro-vertebral angle.

Dorsal Region.—The vertebræ in this region, taken as a whole, are much smaller than those of the lumbar, and differ from them in several important points; the body is more circular, and shorter in its vertical measurement before than behind, while on its sides posteriorly, above and below, two small facettes are visible, the superior being a little larger than the inferior, both covered with cartilage, for the purpose of articulating with corresponding facettes on the heads of the ribs. The pedicles are not so strong as those in the lumbar region, while the transverse processes, which pass more obliquely backwards and outwards, possess far greater strength, and gradually increase in thickness as they approach their termi-

nation: on their extremities, but situated anteriorly and superiorly, are small concave articular surfaces, covered with cartilage, for articulating with the tubercle of the rib. The articulating processes are oval and flattened, the superior looking backwards and slightly outwards, while the inferior look forwards and inwards. The laminæ are short but very deep, and, like those in the lumbar region, give attachment to the ligamenta subflava, while the spine is long, and curved downwards, so as to overlap the one immediately below; this process is triangular in shape, gradually tapering to a point, where it is slightly incurvated, while the spinal canal is oval in figure and extremely small.

The dorsal region presents four peculiar vertebræ for consideration: the first, fourth, eleventh, and twelfth; of these, the first has a whole and a half facette on either side of its body. The eleventh and twelfth have each but a single facette on the side of the body, and none on their transverse processes. The fourth is known at once, as being the smallest of the whole, frequently presenting a depression on its left side for the thoracic aorta.

Cervical Region.—The vertebræ of this region are much smaller, as a class, than those of the other divisions of the spinal column. The body is much thinner, and rather deeper in its vertical measurement anteriorly than posteriorly, being concave on its upper surface from side to side, and convex from before backwards, the reverse obtaining on its inferior. The pedicles are extremely short, and the transverse process merely rudimentary and apparently double, owing to a small process of bone that connects it to the side of the body. In it is observed a small round foramen, through which the vertebral artery, veins, and a plexus of nerves pass; the anterior extremity of the transverse processes gives attachment to the longus colli, rectus capitis anticus major, and anterior scalenus, and the posterior to the scaleni, medius and posticus, splenius colli, and levator anguli scapulæ; while the intertransverse muscles are attached to them both anteriorly and posteriorly. The articulating processes, covered with cartilage, are round and nearly flat; the superior looking backwards and upwards, the inferior forwards and downwards. The laminæ are flattened and comparatively strong, terminating in the spine, which stands out horizontally from the bone, and presents posteriorly a bifid arrangement, for the purpose of increasing space for the attachment of the cervical aponeurosis, trapezius, and splenius. The spinal canal is very large and triangular, owing to the great amount of motion that exists in this region

The particular vertebræ that are found in this portion of the column are the first, or atlas; the second, or axis; and the seventh, or vertebra prominens. Of these, the last is easily known from its

greater size and resemblance to a dorsal, and is also remarkable for the extreme length of its spinous process, which, jutting out boldly backwards, presents but a single tubercle, giving attachment to the ligamentum nuchæ and lesser rhomboid; its tranverse processes are also very long, resembling rudimentary ribs; and when a hole exists in them, it is for transmission of the vertebral veins only, and not the artery.

Atlas.—This vertebra, as contrasted with the others, presents a very remarkable appearance, being nothing more than a mere circle of bone, with the lateral masses applied to its sides; it has been divided into two portions, called its anterior and posterior half-arches, the former being much smaller than the latter. In front, on its anterior half-arch, it presents a tubercle in the mesian line, for the insertion of the cord-like process of the occipito-atloid ligament, while external to this point it is concave, for the origin of the rectus capitis anticus minor; behind, it is grooved and covered with cartilage for articulation with the odontoid process, while its upper margin gives attachment to the broad occipito-atloid ligament, and its inferior, which is much thicker, to the atlo-axoid. The spinal canal is very large, but divided into two parts by the transverse ligament, which runs across it, and is attached by either extremity to two tubercles on the inner side of the articulating processes, the odontoid process occupying the interval between it and the anterior half-arch, while the medulla spinalis fills up the space between it and the posterior half-arch: the transverse processes are short, but extremely thick, especially at their extremities; and are still traversed by the vertebral holes, but here directed obliquely backwards and upwards according to the course of the artery of the same name. The following muscles are found to be attached to them:—Superiorly, the rectus capitis lateralis; posteriorly and superiorly, the superior oblique; and inferiorly and posteriorly, the inferior oblique; the lateral occipito-atloid ligament is also connected to its upper surface. Immediately internal to the transverse, are the articulating processes; they are deeply concave, oval in shape, look upwards, backwards, and inwards, and articulate with the condyles of the occipital bone; while the inferior are more circular, slightly concave, and look downwards and inwards for articulating with those of the axis. Directly behind the oblique processes, and not in front, as in the other vertebræ, are the grooves for the transmission of the first and second spinal nerves. The laminæ, forming the posterior half-arch, are thick and rounded, and present on their upper surface a well-marked groove for the vertebral artery, which here rests on it before entering the cranial cavity, but is partially separated from it by the ganglion of the suboccipital nerve,

as it emerges from the medulla. The superior margin of the posterior half-arch gives attachment to the posterior occipito-atloid ligament, and the inferior to the atlo-axoid. Properly speaking, this vertebra has no spine, presenting posteriorly merely a tubercle from which the recti capitis minores take their origin.

Axis.—This bone is always easily recognised by the tooth-like process which springs from the upper part of its body. This remarkable appendage of this vertebra, termed also the odontoid, is very similar in appearance to a canine tooth, and is covered with cartilage nearly in its whole circumference, articulating anteriorly with the posterior part of the anterior half-arch, while posteriorly it is retained in position by the transverse ligament, which embraces it behind. This portion, which is slightly constricted, and called its neck, is surmounted by a process of bone partially enlarged—the head, which presents a groove on either side for the attachment of the ~~check~~ ligaments, while to its apex, which is extremely sharp, is connected the ligamentum suspensorium. The body is exceedingly deep from above downwards anteriorly, but shallow in the same direction posteriorly; this is owing to the anterior inferior lip being prolonged to some extent so as to overlap the vertebra below to guard against dislocation. The body presents in front a concave depression on either side, with an intervening ridge; to the first are attached the longi colli muscles, and to the last the commencement of the anterior vaginal, or common ligament of the spine. The transverse processes are extremely short, and rounded at their extremities, affording attachment to the Levator anguli scapulæ, splenius, and posterior scalenus; the articulating are nearly flat, large superiorly, circular, looking upwards and outwards to articulate with those of the atlas; while the inferior are concave, and much smaller, looking downwards and forwards to unite with those of the third vertebra; the laminæ are exceedingly thick and strong, and terminate in a well-marked triangular spine, which bifurcates posteriorly, to give attachment to the recti postici majores, and the obliqui inferiores.

Development.—Each vertebra, as a general rule, is developed from three primary points of ossification, viz.:—one for the anterior part of the spinal canal corresponding to the body, and one for each of the laminæ; the osseous points being generally visible from the fortieth to the fiftieth day. The lateral points gradually expand and become united posteriorly about a year after birth, but they do not become connected with that of the body for nearly five. The complementary points are five in number, viz., one for the upper, and one for the lower part of the body, which thus appears in fœtal life to be composed of three separate discs, which remain laminated

for a lengthened period after birth; there is also one distinct point for the extremity of each transverse process, and one for the spine. The union between those complementary points is complete about the twenty-fifth year.

The atlas is developed from six points of ossification, viz., two for the anterior half-arch, two for the posterior, and two for the lateral masses—those for the posterior part of the body appearing about the end of the sixth week, while those for the anterior are not visible for some time after birth. The axis has two additional points for the odontoid process; they spring from the upper part of the sides of the body, and can be detected about the sixth month. The seventh cervical has also an additional complementary point for its transverse processes, and the same remark may occasionally be applied to those of the first lumbar.

SACRUM.—This bone is found at the lower part of the spinal column, interposed between the last lumbar vertebra above, and the coccyx below, and having the ossa innominata on either side; triangular in shape it presents the following parts for consideration, viz., a base which is turned upwards and forwards; a truncated apex which looks downwards and backwards; two lateral margins, and an anterior and posterior surface. Directing our attention first to the base, we find occupying its central portion a large articular facette, transversely oval, cut off obliquely from before downwards and backwards, for uniting with the last lumbar vertebra; while on either side of it, appear two large masses of bone, analogues of the transverse processes, directed obliquely downwards and forwards, and concave from side to side; these have been called the shoulders of the sacrum, and afford support to the iliac vessels with the sympathetic and lumbo-sacral nerves. The inferior extremity or apex, transversely oval, and generally speaking convex with a slight irregular depression in the centre, is covered with cartilage, and articulates with the base of the coccyx. Its lateral margins, cut off obliquely from above and in front downwards, backwards, and inwards, present above, an auricular facette, covered with cartilage, and irregularly concave, for uniting with the ossa innominata on either side, between which it is firmly wedged, while below it is very irregular in its outline, but comparatively thin, where it enters into the formation of the great ischiatic notch, and has the greater and lesser sciatic ligaments connected to it.

The anterior surface of the bone is very concave from above downwards, and also slightly so from side to side, except superiorly where it bulges considerably forward in the mesial line. On it are observed four transverse ridges, generally very well marked, indicating the original division of the bone into five distinct pieces, and in

those ridges, about the centre appear the four holes for the transmission of the sacral nerves—the two superior being very large, while the two inferior are comparatively small; to the surfaces of the bone, between each of the foramina, is attached a fasciculus of the pyriformis; while internal and external to them, sweep down the lateral and middle sacral arteries, which throw small branches into each hole, to pass out posteriorly, to anastomose with the lumbar and gluteal. The posterior, as contrasted with the anterior, surface is rough, convex, and extremely irregular, presenting, in the median line, a series of elevated tubercles, which gradually diminish in size from above downwards; they are generally five in number, and of these the three first may be either distinct from each other or amalgamated together, while the fourth and fifth bifurcate, and appear as small prominences, two on either side of the termination of the sacral canal, to which the strong ligament for its completion posteriorly is attached; this central row of eminences may be considered as analogous to the spinous processes of the true vertebræ. A little external to these is a second row of tubercles, very badly marked, representing the articular processes, while still more externally are the four sacral foramina for the transmission of the posterior nerves, but much smaller in size than those on the anterior surface; passing out still farther, a third series of eminences appears, which may be regarded as the type of the transverse processes, being intermediate in size between the first and second rows. The several elevations just described, give attachment to the lumbar fascia, extensors of the spine, glutæus maximus, latissimus dorsi, and the powerful sacro-iliac ligaments. The spinal canal, which occupies the centre of the bone, is large and triangular in shape above, but flattened and extremely contracted inferiorly, and bordered superiorly and laterally by the oblique processes, which look backwards and inwards, and are deeply concave from side to side, for articulation with the last lumbar vertebra. The sacrum articulates with four bones; the ossa innominata on either side, the last lumbar above, and the coccyx inferiorly.

Coccyx.—This is an extremely small bone, consisting of four, sometimes of five pieces. In shape triangular, with the base turned upwards, it presents an articular facette covered with cartilage, for uniting with the last bone of the sacrum, with which it forms a moveable joint up to about the twentieth or twenty-fifth year in the male, and the forty-fifth in the female. Its apex points downwards and forwards, and terminates in a small nodule of bone, to which the ano-coccygeal ligament is attached. Its margins are very irregular, and give origin to the sciatic ligaments, and insertion to the posterior fibres of the levatores ani and coccygæus. The an-

terior surface is smooth and concave from above downwards, and contributes to support the rectum as it descends, while the posterior, convex and rough, presents above, and on each side of the mesial line, two small demi-tubercles, which are generally found to be firmly united by bone to corresponding processes on the lower part of the sacrum, thus circumscribing a foramen for the transmission of the fifth sacral nerve; to this surface is attached the aponeurosis of the glutæus maximus.

Development of the Sacrum.—This bone, taken as a whole, has numerous points of ossification; but as they vary in the several pieces of which it is composed, it may be preferable to examine each separately. The three first are developed exactly as those of the true vertebræ, viz., one point for the body, one for each lamina, and one for each lateral mass, making five points in all; in the two last, however, only three are found, viz.: one for the body, and one for each lamina; thus constituting twenty-one primitive points in all; but at a later period of life twelve complementary points appear, viz.: two for the upper and lower parts of the body of each bone, and one for each articulating surface for the ossa innominata, thus increasing the number to thirty-three altogether. Each separate piece of the coccyx is developed from a single point of ossification; but the ossific nucleus is much later in its appearance in the coccygeal region than in the sacral, while the union of the several bones of both sacrum and coccyx may be said to be completed about the twenty-fifth year This rule is of course liable to many exceptions.

THE SPINE IN GENERAL.

Before proceeding further it will be necessary to take a general view of the spinal column as it appears in the adult male human being, and then to describe briefly such modifications as may be induced in it by age, habit, or disease. Thus when observed on its anterior aspect we observe it to present the appearance of a knotted stick, tapering away at either extremity, but gradually enlarging at some distance below its centre, constituting, in fact, two pyramids, with their bases opposed to each other, at the upper part of the sacrum. However, on a closer examination it will be found that the superior pyramid may be again subdivided into three smaller ones, this subdivision depending upon the unequal size of certain vertebræ, which present too obvious a difference in figure to be easily overlooked. As for instance in the case of the last lumbar vertebra which is exceedingly large, while the fourth dorsal is comparatively as small, and hence the first pyramid is formed with the base below at the fifth lumbar, and the apex above at the fourth dorsal. Again,

we observe a gradual increase in size, as far as the seventh cervical, and thus we have the second pyramid with its apex below, united to that of the first; and its base above. At the seventh cervical, the vertebræ diminish from the seventh up to the second, the odontoid process of which forms the apex of the third cone, its base being opposed to and at the same point as that of the second. The spinal column thus constituted is by no means perfectly straight in its outline, but presents four great curvatures in its course downwards, and these, although differing from each other in the manner in which their saliency is concerned, still however, are so arranged as to modify and counterbalance each other, in a very remarkable manner. Thus the convexity is directed forwards, in the cervical region; and corresponds to the longus colli and anterior vaginal ligament, supporting the pharynx, larynx, and upper part of the œsophagus. Again, in the dorsal region the concavity is turned forwards and is covered almost entirely by the broad common ligaments, an arrangement affording ample space for the pericardium and great vessels, with the several parts contained in the posterior mediastinum. The lumbar region presents a well-marked convexity forwards, partially concealed by the attachments of the psoæ and crura of the diaphragm, but appearing prominently below, where it is only covered by its shining ligament, the direction of this curvature having a tendency to throw the abdominal viscera forwards, and cause them to rest on the arch of the pubis as a firm basis of support. Lastly, the concavity is forwards in the sacral region, and has resting on it the rectum, pyriformis and sacral plexus, while the deep recess which is thus formed, increases the capacity of the pelvis, and adapts it for the reception of the several important parts which it naturally contains.

But in addition to those curvatures which all observe an antero-posterior direction, we likewise have two others situated laterally, one in the dorsal, the other in the lumbar region ; the convexity of the first being turned to the right side, that of the second to the left. To account for the production of the first of those curves or that in the dorsal region, two reasons have been assigned. By one party it has been supposed that the thoracic aorta lying on the left side has a tendency, by its pulsations, gradually to force the vertebral column in the opposite direction; while others, with more probability, assert that the more frequent use of the right hand, naturally tends to draw the spine in that direction. The last observation seems to be the correct explanation of the fact, as it has been remarked that in *left-handed* individuals the convexity of the curve is always turned in that direction; and in those pursuing laborious occupations the deviation from a straight line is invariably found to be more obvious than in those whose avocations require the application of less physical

exertion. It may be merely requisite to state, that the slight curve in the lumbar region is there only to antagonize that which exists in the dorsal, and is appareut in a greater or lesser extent, according to the degree of intensity that may prevail in the latter.

If we now direct our attention to the posterior part of the spinal column, we will observe the same alternating curvatures as on its anterior surface, but of course turned in an opposite direction. In its mesial line, the spines jut out prominently, forming a well-marked ridge from above downwards, with varying degrees of prominence. Thus in the cervical region the spine of the axis stands boldly out; the third, fourth, and fifth are more depressed; while those of the sixth aud seventh, particularly the last, are very prominent. With the exception of the first and last, all are bifid and exceedingly strong, for the attachment of the numerous muscles which move the head and neck. Iu the dorsal region, they are differently arranged as they bend downwards and backwards—overlappiug each other, so as to limit in a great measure all attempts at extension. In the lumbar region, they stand out nearly at a right angle with the column, and are thick and strong, but separated from each other by a considerable interval, while those of the sacro-coccygeal region, generally amalgamated with each other, gradually diminish in size, until they are ultimately lost in a depressed triangular space—the termination of the spinal canal. On either side of the spine appear deep grooves, known as the vertebral furrows, affording attachment to the great extensors of the spine, which present in the living subject two well-marked, prominent, fleshy masses ou either side of the mesial line; for during life a depression marks the course of the spine itself, this depression being deep and obvious according to the muscularity of the individual. The lateral aspect of the spinal column presents for observation the transverse processes, with the several peculiarities characteristic of each region. Thus they are short and bifid iu the cervical; thick, strong, and directed backwards, with a facette on their extremity, in the dorsal; and pointed and comparatively weak in the lumbar. Situated in close proximity to the roots of the transverse processes are the oblique, forming an irregular, wavy line from above downwards, while still more anteriorly, between these and the body, are the intervertebral holes, large and double in the sacral region, gradually diminishing in size in the lumbar and dorsal, and again expanding in the cervical; through these holes pass the several nerves from the spinal marrow, with the communicating branches between the intra and extraspinal veins, and a few small arterial twigs destined for the nutrition of the adjacent parts.

The spinal column thus formed contains within it the spiual cord, lodged in a bony cavity which extends from the atlas to the coccyx.

This canal is not of uniform dimensions, being largest in the cervical and most contracted in the dorsal region; this variation in size depending on the different degrees of mobility which the column enjoys in its several parts, the canal being exceedingly small where motion is limited, as in the dorsal region; but where, as in its upper and lower portions, it can be moved in almost every manner and that to a very great extent, nature, in order to prevent the injury that might ensue from the cord coming into collision with its unyielding walls, has enlarged the bony case for its reception, while she has still further added to its security by placing in front of it the dense bodies of the vertebræ, behind and on its sides the spinous and transverse processes, which, standing boldly out, receive and break the shock of the blow that under other conditions might have been attended with dangerous results.

If we now direct our attention to the appearance of the fœtal spine, we are at once struck by the difference that is apparent between it and that of the adult. It still preserves the cone-like shape, but is inverted, the base being above at the cranium, and the apex below at the sacrum—the diminution in size being beautifully tapering, and presenting as far as the true vertebræ are concerned but a single curvature, the concavity of which looks forwards, while the sacrum and coccyx, united to it at nearly a right angle, are remarkably narrow from side to side, and devoid of that hollow anteriorly, so well-marked in the adult subject. As we have already alluded to the ossification of the vertebræ separately, it may be here only necessary to observe, that the osseous germs are first visible in the laminæ, and shortly afterwards in the bodies, at a period varying from the sixth to the seventh week. They are extremely minute at first, but gradually enlarging, at length unite, those of the laminæ about a year after birth, but the laminæ are not joined to the body for four or five. The reason for the early development of those particular parts is obvious, nature being anxious to complete the bony ring for the protection of the important organ, the spinal marrow. This is proved by the late appearance of the ossific nuclei in the processes, as they are comparatively of little consequence, and accordingly are not completed till an advanced period—the fifteenth or twentieth year. The atlas is, however, peculiar in its ossification, for while its posterior half-arch follows the general rule of the laminæ of the other vertebræ, no ossific point appears in its anterior portion till a year after birth. As we have already alluded to the late period in which the osseous change is effected in the sacrum and coccyx, it is quite unnecessary to review them here.

THE THORAX.

In pursuing the description of the osseous framework of the body, the thorax naturally comes next after the spinal column, both from its direct connexion with it, and also from the very important place which it holds in the animal economy. It is a large cavity, imperfectly conical, situated rather above the centre of the trunk; and, in addition to the other structures entering into its formation, has the ribs and sternum, which we shall now proceed to describe.

Ribs.—These bones from their position and use, have been classed both as long and flat bones, acting in the one instance as levers, to which the muscles are attached, and in the other as flat ones to enclose a cavity. They are twenty-four in number, or twelve on each side, and from the different manner in which they are situated with regard to the sternum, they have been divided into sternal, asternal, and floating. The first of these are seven in number, and are directly connected to the sternum by their own proper cartilages; the second consist of the three succeeding, which, although attached to the sternum, are only so indirectly, for their cartilages unite after proceeding for some distance, and then the common one formed by the three becomes blended with that of the seventh, which gives them a species of connexion to the sternum; the two last are called floating ribs from the manner in which they seem to move in the cavity, having only a single point of attachment to the vertebral column by their head, while their anterior extremity, tipped by a short process of cartilage, has no bony connexion whatever.

All the ribs may be said to be similar to each other in their principal characteristics, with the exception of the first, eleventh and twelfth, and these contain striking peculiarities which will be more fully noticed hereafter. Thus it may be stated as a general rule, that they increase in length from the first to the seventh, and again diminish gradually from the seventh to the twelfth; while with respect to breadth, they decrease slightly from the first to the last; but this rule is liable to many variations, as an extended examination of those bones in different subjects will clearly demonstrate.

A rib is divided into a head, neck, tubercle, angle, and shaft; those several portions following each other in order from the spine to the sternum. Of these, the head is triangular in shape, presenting on its extremity two oval concave facettes covered with cartilage, the inferior slightly larger than the superior, for articulation with the cavity of reception formed by the approximation of the two contiguous vertebræ and the intervening intervertebral disc; its anterior surface is slightly rough for the origin of the stellate ligament, while

the posterior is very irregular, and gives attachment to the scattered fibres of the imperfect capsular. The neck of the rib is that constricted portion, about an inch in length, intercepted between the head and tubercle; it is rounded, but occasionally presents on its upper part, about its centre, a prominence into which is inserted the anterior costo-transverse ligament; while from this point the levatores costarum stretch out along the upper margin, nearly as far as the angle. At the termination of the neck, and on its posterior surface, the tubercle is placed; it is divided into two portions; an internal and inferior, round, convex, covered with cartilage to articulate with the transverse process of the adjacent vertebra on which it rests; and an external and superior, roughened for the attachment of the posterior costo-transverse ligament. From the tubercle the bone passes directly outwards for about an inch and a half, then turns abruptly forwards and slightly downwards, forming what has been called the angle of torsion, and to that part of the bone intercepted between it and the tubercle on its posterior surface are attached the great extensors of the spine. The shaft is that flattened portion of the bone between the angle behind and costal cartilage in front; it presents for examination two surfaces, an external and internal, and two margins, a superior and inferior. The external surface is flattened, very convex from before backwards, and broader posteriorly than anteriorly; it gives attachment to the muscles of respiration, viz.: the serrati, pectorals, obliqui externus, rectus, latissimus dorsi, &c.; while the internal surface, concave from behind forwards, is covered only by the pleura. The upper margin is rounded and smooth, and forms the segment of a circle, smaller than that of the lower, which is also deeply grooved for the reception of the intercostal vessels and nerves. This groove, occupying about the posterior two-thirds of the bone, is extremely deep behind, but is gradually lost as it approaches its anterior extremity; its external lip being always much better marked than its internal, while to each is attached the corresponding layer of intercostal muscles. Its anterior extremity, which is slightly expanded, is deeply excavated for the reception of the costal cartilage, which is firmly imbedded into it.

The first rib may be always recognized immediately by its peculiar shape, forming as it does, a larger segment, but of a smaller circle, than any of the others, and presenting no angle of torsion. Its head, small and rounded, has only one facette, as it articulates with one vertebra only, viz. the first, while its neck is contracted and small, and its tubercle very prominent, differing from all the rest in the fact of its articulating facette being placed on its upper portion, and not on its lower. Its two surfaces, very broad and flat, can no longer be called external or internal, but superior and inferior, as the one looks almost directly upwards, the other downwards; the following pecúli-

arities being visible on its upper, viz.:—a superficial groove anteriorly for the subclavian vein; behind this, a tubercle for the attachment of the scalenus anticus; behind this, another groove for the subclavian artery; and posterior to this, a longitudinal ridge for the insertion of the scalenus medius. The under surface presents nothing very remarkable, as it is devoid of the groove which the others generally exhibit. The point of this rib is flattened, and tipped with a cartilage, extremely short, as contrasted with the succeeding ones.

Again, the two last ribs are very unlike the others, as they are more rounded and slighter in appearance; they also form smaller segments of larger circles, and present but a single facette on the head, as they articulate with one vertebra only. They have no neck, properly speaking, and the tubercle is likewise absent, not being required, as they have no connection whatever with the corresponding transverse process. The angle and groove for the vessels is likewise deficient, and their cartilage is also very short and buried between the layers of the abdominal muscles.

The ribs may be said to articulate only with the vertebral column, but at two points, as they are only connected to the sternum by means of cartilage; they are developed by a single primitive point of ossification, which appears in the body, from the fortieth to the fiftieth day; but there are also, in addition, two complementary points, one for the head, and one for the tubercle, which become united to the shaft, not until about the fifteenth year.

Sternum.—This bone, occupying the front of the thorax, is not placed vertically, but slopes obliquely downwards and forwards, so as to increase the capacity of the lower part of this cavity; it has derived its name from the fact of its lying in front of the heart and pericardium, forming so to speak a species of shield for the protection of those important parts. In early life it consisted of five distinct bones; and the division which existed at that period is generally marked out in the adult bone by a series of ridges, which are, however, nearly entirely effaced in more mature age, with the exception of that between the first and second pieces. The persistence of this, with the addition of the xiphoid cartilage, has given to it a supposed resemblance to an ancient sword, and hence the older anatomists have applied the following names to the three parts of which it is composed; the first piece they termed manubrium, or the handle; the second, gladiolus, or mucro, signifying the blade; and the third processus ensiformis, or point. It is, however, preferable, when examining it, to regard it only as a single bone, of an hour-glass shape, as by this means we can describe its two surfaces, its two margins, and superior and inferior extremities. The anterior surface is slightly convex from above downwards, and the same from side to side above,

but flattened, and a little concave in the same direction below; it is rough, and gives attachment to the aponeurosis of the pectoral muscles of opposite sides, which cover it nearly in its entire extent, while its posterior aspect, concave from above downwards, and concave from side to side above, but completely flat below, is covered by the posterior sternal aponeurosis. This surface, much smoother than the anterior, corresponds to the anterior mediastinum, and gives origin, above, to the sternohyoid and thyroid muscles, and below to the triangularis sterni. Its margins, taken generally, are very irregular, owing to the pits or depressions with which they are marked, for the reception of the cartilages of the ribs; these depressions, concave and oval in shape, are arranged in the following manner: a whole and a half facette on the side of the first bone; four whole and two half ones on the side of the second—the half ones being found above and below, with the whole ones between them; and, ultimately, a demifacette on the upper part of the xiphoid cartilage—thus constituting altogether the seven, for the articulation of the cartilages of the true ribs. The superior extremity of the bone is extremely thick, as contrasted with the inferior, presenting in the centre a rounded surface from before backwards, but concave from side to side, usually known as the fourchette, across which the interclavicular ligament passes, and is united to it by dense areolar tissue; this surface is limited on either side by the depression for the extremity of the clavicle, forming an articulating facette, concave from within downwards and outwards; slightly convex from before backwards, looking upwards, backwards, and outwards, and covered with cartilage for its reception. The inferior extremity, exceedingly rough, is connected to the xiphoid cartilage, with which we find it usually ossified in advanced life.

The Xiphoid or Ensiform Cartilage may be regarded as the continuation of the sternum downwards, and is exceedingly irregular in shape, as it may be either square or triangular, hang vertically, or be turned forwards, backwards, or to either side; it gives attachment to the linea alba, the recti, and flat abdominal muscles, the diaphragm, &c.

The sternum articulates with the clavicles on either side and with the costal cartilages which connects it to the true ribs. In structure it is exceedingly spongy in the central parts, two thin plates of compact tissue covering it in anteriorly and posteriorly; while in its development it is comparatively late, the first ossific point not appearing till after the fifth month, for the first piece; while those for the others, are not visible for some time longer; generally speaking, there is a single point for each separate piece, but these are very often found double. The hole which exists occasionally between the first and second pieces is clearly an arrest of develop-

ment, occurring in those cases where there are double ossific points for the upper portion.

The costal cartilages, which complete the thorax in front and laterally, are remarkable for their elasticity and promptness to recover their original shape and position when distorted by the motions produced by the muscles of the thorax, and hence they perform an important function in respiration, by aiding the expiratory muscles, in restoring the cavity to its original dimensions after inspiration. They are twelve in number, and, like the ribs, increase in length from the first to the seventh, and again gradually decrease from that point to the twelfth. The first costal cartilage is remarkable for its shortness and thickness, and for the wide interval which separates it from the one below. The second, third, and fourth present no peculiar features; but the fifth, sixth, and seventh are found to approach each other, so as to be almost completely in contact at their point of connexion with the sternum. The eighth, ninth, and tenth, much narrower, and more curved than the true, taper off gradually towards their anterior extremity, become blended with each other, and the common cartilage thus formed is ultimately joined to that of the seventh rib, thus affording them a species of attachment to the sternum in front; whilst the eleventh and twelfth, only a few lines in length, terminate abruptly between the layers of muscles constituting the abdominal wall. If we now turn our attention to the mode of union between those cartilages and the osseous structures which they connect, we will find, as already explained, that there exists in the extremity of the rib a deep oval depression, into which the cartilage is imbedded, and the union between the two is still further strengthened by a process of thin but extremely strong fibrous tissue, which stretches from the one to the other. The cartilage and the sternum are bound together in nearly a similar manner, the cup-like cavity in the latter receiving the elongated extremity of the former, with fibrous bands stretching between both, but still this difference exists, that the chondro-sternal articulation almost always exhibits the remains of a true synovial membrane.

The thorax, formed by the union of the parts just described, with the addition of the dorsal vertebræ and intercostal muscles, to fill up the intervals between each rib, holds an appropriate position, both in size and construction, between the other two great cavities —the cranium and abdomen,—being much larger than the one, but smaller than the other. The structure of its walls, too, partly osseous and partly muscular, bestows upon it a certain degree of mobility, limited however, being by no means equal to that of the abdomen, while it forcibly contrasts with the rigid, unyielding character of

the cranial cavity. In the well-formed male adult subject, when the upper extremities are removed, it presents a conical figure, with its truncated apex turned upwards. The anterior wall, sloping downwards and forwards, flattened, and a little more than half the length of the posterior, is formed by the sternum and costal cartilages; the lateral walls, rounded in their outline, and expanding as they descend, are constituted by the ribs and intercostal muscles, while the posterior, flattened like the anterior, but convex from above downwards, is made up of the twelve dorsal vertebræ and the angles of the ribs. If we now contrast the inner part of the cavity with the outer, which we have just described, we will find that they accurately correspond with each other, of course substituting what is convex in the one for what is concave in the other, the posterior wall, however, presenting the following peculiarity on its internal aspect, viz., the bodies of the several vertebræ bulging forwards into the thorax, and forming an elevated ridge in the mesial line, while a deepened gutter exists on either side, between the prominent spine and the angles of the ribs, a conformation peculiar to erect man alone. In comparing also the organs of circulation with those of respiration, we observe at once that a great disparity exists in their relative size, and we accordingly find that the former is placed in the contracted interval between the vertebral column and sternum, while the greater bulk of the latter is accommodated in the wider space intercepted between the angles of the ribs and the costal cartilages. The thorax communicates above with the cervical region by what has been termed its upper outlet, which is of an oval form, its greatest breadth being from side to side, and cut off obliquely from above and behind, downwards and forwards; this aperture is bounded anteriorly by the first bone of the sternum, extremity of the clavicle, and inter-clavicular ligaments; laterally by the first rib, and behind by the body of the first dorsal vertebra and last cervical. It is traversed by a vast number of most important parts, some descending from the neck to the chest, and others again taking a contrary direction. These will be all enumerated in their proper place. The inferior aperture of the thorax is of much greater extent than the superior, while it is of the same oval figure, but, cut off obliquely from before, downwards and backwards; it is bounded anteriorly by the xiphoid cartilage; laterally by the cartilages of the last true, and all the false with the last rib itself; and posteriorly by the last dorsal vertebra and first lumbar. In the natural condition of the parts a strong muscle, the diaphragm, is thrown across this opening, forming a partition between the abdominal and thoracic cavities, and through certain foramina in it, parts are transmitted essential to the vital functions of the individual. The obliquity of these two

openings—the superior and inferior outlets—explains the reason why the vertical measurement of the posterior wall is so much longer than that of the anterior.

In the female subject, the chest is shorter than that of the male, the abdomen being comparatively longer for the purposes of utero-gestation, but at the same time it is deeper in the antero-posterior direction. The shape likewise is altered by the habit of using stays and ligatures around the body, producing gradually a striking alteration in its original form, narrowing the inferior outlet, and thus rendering the whole of an ovoid figure. The injurious effects induced by this mode of proceeding are not confined to the lungs only, which are forcibly thrust upwards, but they affect likewise the abdominal viscera, by compressing and forcing downwards from their ordinary position the liver, as well as the stomach and transverse colon.

If we now direct our attention to the fœtal thorax, we will find that it is remarkable for its very great expanse inferiorly, due to the large size of the liver at this period of life; for its extreme shortness from above downwards, owing to the non-development of the sternum; for its contraction from side to side, arising from the want of expansion of the lungs; and for its depth from before backwards, depending upon the large size of the thymus gland, and the greater comparative magnitude of the heart. These several peculiarities give to the fœtal chest a striking resemblance to the same cavity in those animals where a want of the clavicle exists, viz., its flatness from side to side, and its equally striking antero-posterior depth; but as the lungs expand, and the thymus gland becomes gradually atrophied, the ribs by degrees assume their rounded form, and their angles begin to make their appearance, while the sternum, hitherto so prominent, now commences to recede. The upper aperture, too, still continues of an oval shape, but its long measurement is, from the same causes, gradually changed, being no longer from before backwards, but from side to side; while the inferior, owing to the diminished size of the liver, as contrasted with what it was at birth, is no longer conspicuous for its relatively vast circumference. Very advanced life has also its peculiarities, as the laboured respiration which so often witnessed in old age, very frequently depends on the ossification of the costal cartilages, a change to which those structures are especially liable.

Clavicle.—We have now to turn our attention to a bone which, from the important function that it performs in the human body, has been justly styled the key, as upon it depends that ready play of the upper extremity, which man possesses in the highest degree, as contrasted with the rest of the creation. It belongs to the class of long bones, but is curved like an italic *S*, and stretches obliquely out-

wards and backwards, from the upper part of the sternum to the acromion process of the scapula. In the description of the bone, it will be necessary to give it two extremities, an internal and external; two surfaces, a superior and inferior; and two margins, an anterior and a posterior. The internal extremity is triangular in shape, having the base turned upwards and forwards, and the apex downwards and backwards; it is covered with cartilage, and its inferior third, which is concave from before backwards, and convex from above and within downwards and outwards, articulates with the corresponding facette of the sternum, while the remaining two-thirds are on a plane higher than the margin of the sternum, and give attachment to the interclavicular ligament. Its circumference immediately around the head is rough anteriorly and posteriorly, for the sterno-clavicular ligaments; superiorly, for the origin of the sterno-mastoid, while below it is smooth, and rests on the cartilage of the first rib, from which it is separated by a small bursa. The external extremity, on the other hand, is flattened, and presents an oval facette covered with cartilage, and cut off obliquely from above and without downwards and inwards, so as to rest on the acromion process; its upper and lower edges being also rough for the attachment of ligaments. Of its two surfaces, the superior is the rounder and smoother, and is directed rather upwards and forwards; its internal third giving origin to the outer head of the sterno-mastoid, while its two external thirds are subcutaneous, and can be easily felt in the living subject, being covered only by the skin and a strong aponeurosis from the deltoid and trapezius. Its inferior surface is more irregular, exhibiting internally a ridge for the insertion of the rhomboid ligament; a little more externally a longitudinal groove for the attachment of the ligamentum bicorne and subclavius muscle, and immediately external to the latter two rough eminences and an oblique line—the one for the insertion of the conoid, and the other for that of the trapezoid ligaments. Its anterior margin, directed also slightly downwards, is convex for its internal two-thirds, and gives attachment to the great pectoral, but concave externally, where it affords an origin to the deltoid. Its posterior edge is rough and convex externally, where it gives attachment to the fibres of the trapezius, but concave internally and smooth, where it embraces the first rib, and permits the great vessels and nerves to pass up and down behind it. As the rule, the clavicle articulates with two bones only, the sternum and scapula, though occasionally it may lie on the cartilage of the first rib. It is developed at a very early period, generally about the thirtieth day, and continues to grow very rapidly, during the term of intra-uterine life. It has only one single primary point of ossification, but sometimes a

complementary nodule is found on its under surface near the sternum, and a second may also sometimes exist for the tubercles of attachment of the coraco-clavicular ligaments. This bone in the female is always easily distinguishable from that of the male, as it is comparatively longer, straighter, and generally more rounded; in fact, it would appear to be more influenced in shape and size, by the nature of the avocations in which the individual may be engaged, than any other bone in the human body.

Scapula.—Belongs to the class of flat bones, and is found on the lateral and posterior part of the thorax, occupying the interval between the first and seventh ribs. Of a triangular form, its base is turned backwards and inwards, while its apex, which is formed by the glenoid cavity, points upwards, forwards, and outwards. In the description of the bone it may be divided into two surfaces, an internal and external; three borders, a superior or cervical, a posterior or vertebral, or base, and an inferior or anterior, or axillary; three angles, a superior posterior, an inferior posterior, and an anterior; and three processes, a coracoid, acromion, and spine. If we now direct our attention to the internal surface we will find it to be concave, and marked by three or four elevated ridges or lines, which give attachment to the subscapular muscle. The external surface, irregularly convex, is divided into two distinct portions by the spine, running from behind forwards, and leaving a fossa above it, called the supraspinous, and another below it, the infraspinous; those fossæ differing from each other in size, the inferior being at least three times larger than the superior. The supraspinous fossa is of an irregular triangular shape and deeply concave, affording attachment to the muscle of the same name, while the infraspinous, which is of a similar figure and convex, gives origin to the infraspinous muscle, except at its inferior border, where it is bounded by an elevated ridge, broad and expanded behind, but narrow and constricted in front. This ridge is divided into two, by a wavy line running from above downwards, and presents a quadrilateral surface posteriorly, for the attachment of the teres major, and a grooved elongated channel anteriorly for the origin of the teres minor; a large foramen is likewise always visible in the infraspinous fossa near its upper part, for the nutritious artery to enter the bone. Of its three margins, the superior is the shortest and most concave; it commences anteriorly, at the root of the coracoid process, where we find a deep notch, and stretches backwards to the posterior superior angle. To the lips of this notch, anteriorly and posteriorly, is attached the transverse ligament, thus converting it into a foramen, through which the suprascapular nerve enters, while the artery of the same name passes above the ligament, perforating the omohyoid muscle, which arises

from it and the adjacent bone; the remainder of the superior border is very sharp, and terminates in the posterior superior angle, which is rounded, and into which the levator anguli scapulæ is inserted. The posterior edge is extremely long and very convex; it gives attachment to the serratus magnus and the two rhomboids, the lesser of the two last-named muscles occupying the space corresponding to the root of the spine, and the greater, the part extending from that point to its inferior angle, over which the latissimus dorsi glides. The inferior or axillary margin is thick, and generally deeply grooved; posteriorly it is embraced by the origin of the teres muscles and subscapularis, while anteriorly, immediately behind the glenoid cavity, it affords attachment to the long head of the triceps. The spine, is that process which commences at the posterior border of the bone by a triangular facette of variable extent, and from thence runs upwards, forwards, and outwards, becoming gradually more prominent, until it ultimately terminates anteriorly, in the expanded acromion process; it presents two margins for consideration; a superior, regular and slightly concave, giving attachment to the trapezius; and an inferior, concavo-convex, for the origin of the deltoid—the triangular facette alluded to above, at its commencement, being covered with a bursa to allow the inferior fibres of the trapezius to glide over it with facility. The acromion, in which it terminates in front, takes a different direction from the spine, being inclined inwards and forwards, and its surfaces are also directly the opposite; it presents an external margin to which the attachment of the deltoid is still continued; an internal border, covered with cartilage and cut off obliquely to articulate with the clavicle; and a pointed process anteriorly, which can be easily felt during life, and is of much importance to the surgeon in accidents of this region, while its surfaces, one of which looks upwards, is rough, for the attachment of the acromio-clavicular ligaments, and covered by a strong aponeurosis from the deltoid and trapezius; and the other, looking downwards, and much smoother, gives attachment to the apex of the triangular ligament. The coracoid process, springs by a thick root from the upper margin of the scapula, anterior to the notch and directly above the glenoid cavity, its first direction being upwards, then forwards and inwards, and ultimately terminating in a blunted extremity, affording origin to the coraco-brachialis in the centre, the lesser pectoral internally, and the short head of the biceps externally; its posterior border gives origin to the transverse ligament; its external margin has inserted into it the base of the triangular, and its internal the costo-coraco-clavicular ligament; its superior surface, which is slightly convex and rough, affords attachment to the coraco-clavicular ligaments, while its inferior, which is smooth and arched, corresponds to the head of the

humerus, and has connected to it anteriorly, the coraco-humeral or accessory ligament of the shoulder joint. The glenoid cavity lies immediately beneath the coracoid process, and is of an ovoid shape, the inferior part broad and rounded, the superior narrow and pointed, where it affords attachment to the long tendon of the biceps; the cavity itself concave, but superficial, is covered with cartilage and surrounded at its margins by the glenoid ligament, which partially deepens it for the reception of the head of the humerus, but at the same time renders it more circular. In its ordinary position it looks upwards, forwards, and outwards.

The scapula articulates with two bones, the clavicle and humerus, while its connection with the trunk, being by muscle, is termed syssarcosis. It is developed from a single primitive point for the body, which is visible about the eighth or ninth week; and four complimentary, viz., one for the coracoid process, generally to be seen at birth; two for the acromion, about the fifteenth year; one for the spine, about the third month; and one for the vertebral border, about the sixteenth year.

Humerus.—Occupies the highest part in the upper extremity, and belongs to the class of long bones; it is comparatively straight, slightly twisted inwards at its lower portion, expanded at either extremity, and constricted in its centre. It presents for consideration a head, anatomical neck, two tuberosities, a surgical neck, shaft, and inferior extremity. The head is a rounded process of bone, forming about one-third of a sphere, situated above on the lateral and posterior part of the shaft, looking upwards, backwards, and inwards, and covered with cartilage, to articulate with the glenoid cavity of the scapula; it is limited all round by an irregular, slightly depressed, wavy line, known as the anatomical neck, into which the capsular ligament of the joint is inserted; while directly below the anatomical neck and on the anterior and internal part of the bone, two prominent processes are observed, called the greater and lesser tuberosities; the former lying on a plane external to the latter, and presenting on its upper parts three well-marked facettes; the most superior for the insertion of the supraspinatus, the middle for that of the infraspinatus, and the inferior for that of the teres minor; the coraco-humeral ligament is also inserted into it. The lesser tuberosity is more conical in shape, and has only one facette for the attachment of the subscapularis. The two processes are separated from each other by a groove, deep above, but broad and shallow below—called the bicipital, because the long tendon of the biceps plays through it in its course downwards and inwards to unite with its second or short head. The bicipital groove has two lips, an anterior or external, to which is attached the pectoralis major, and a posterior or

internal, to which is connected the latissimus dorsi and teres major; the space intercepted between the insertion of those muscles and the tuberosities, having been called, from the frequency of fractures in this position, the surgical neck. To the external part of the shaft and below the facette for the teres minor, the external head of the triceps is attached; while from its internal surface, below the insertion of the teres major, its inner head arises. The shaft of the bone is irregularly prismatic, presenting three margins: an anterior which is, truly speaking, the external lip of the bicipital groove, prominent above, depressed and nearly lost below; an internal, which must also be regarded as the inner lip of the same groove, but much more elevated below, where it forms the internal condyloid ridge; and an external, which is scarcely visible above, but well-marked inferiorly, where it forms the external condyloid ridge. Those three ridges naturally divide the bone into as many surfaces, an external, internal, and posterior. Of these the posterior is rounded, slightly convex from above downwards, and deeply-grooved by the musculo-spiral artery and nerve, its entire surface being clothed by the triceps. The external side presents, a little above the centre, a well-marked V-shaped crest for the insertion of the deltoid, and on either side of it a furrow or groove for the origin of the brachialis anticus, the two heads of which embrace the tendon of the deltoid. The internal surface, which is rather flat, has a rough portion about its centre for the insertion of the coraco-brachialis. The inferior fifth of the bone is of a triangular shape, expanded and flattened out below, twisted inwards, and bounded on either side by the condyloid ridges. Of these the external is by far the most prominent and best marked, having its lip curled forwards, and terminating below in the external condyle; it gives origin to three muscles, viz., to the supinator radii longus, which occupies its upper third; to the extensor carpi radialis longior, which is attached to the middle; and to the extensor carpi radialis brevior, which arises from its lower; the external intermuscular septum is also connected to its posterior edge, separating the origin of those muscles from the triceps. The internal condyloid ridge is much thicker, more rounded, and depressed than the last; a little anterior to it, and about the centre of the shaft is the foramen for the nutritious artery of the bone, directed downwards; while the internal intermuscular septum is attached to it for its whole extent, separating the triceps from the brachialis anticus. If we now direct our attention to the two condyles and contrast them with each other, the internal will be found to be much the stronger and more prominent: being conical in shape, rounded anteriorly, flattened posteriorly, having an inclination backwards, and giving origin to the powerful flexors and

pronators of the fore-arm. The external condyle is smaller, and lies on a plane inferior to the internal, affording origin to the extensors and supinators. The inferior extremity of the humerus is twisted forwards and cut off obliquely from above and without, downwards and inwards, presenting a series of processes which may be thus enumerated from without inwards. First, the capitulum, oval in shape, covered with cartilage, looking downwards and forwards for articulation with the radius; secondly, a groove, shallow and limiting the latter process internally; thirdly, a ridge slightly elevated, the external boundary of, fourthly, the trochlea, a large articular surface for the sigmoid notch of the ulna, which is concave from side to side, convex from before backwards, limited behind by a deep depression for the olecranon process during extension of the fore-arm, and for the Haversian gland, and in front by a shallower excavation for the coronoid process during flexion; those depressions occasionally communicate, and at all times are separated merely by a thin plate of bone; the aspect of the trochlea is downwards, forwards, and outwards. The fifth and last process is the epitrochlea, which constitutes the internal lip of the last-mentioned articular surface; it is prominent and well-marked, forming three-fourths of a circle, oblique on its external aspect, and covered with cartilage, flattened on its internal, and presenting numerous foramina for the passage of nutritious vessels.

The humerus articulates with three bones:—the scapula above, and the radius and ulna below. It is developed by seven points of ossification: one for the body, which is visible from the fortieth to the fiftieth day; one for the head; and one for the great tuberosity; one for the capitulum; one for the trochlea; and one for each condyle; making seven in all. The last six make their appearance from the first to the twelfth year, but they are not all united together, so as to constitute the entire bone, till the twentieth.

Ulna.—This likewise belongs to the class of long bones; and for the purposes of description may be divided into an olecranon and coronoid process, separated by the great sigmoid cavity; a shaft, a head, and styloid process. Of these the olecranon forms the highest point of the bone, and may be justly regarded as the continuation upwards of the shaft. On observing it superiorly, we perceive it to be rather quadrilateral in shape, rough on its surface, and covered by a bursa, which the tendon of the triceps, inserted into its posterior margin, plays over, while its internal edge gives origin to the flexor carpi ulnaris, and its external to the anconeus; its posterior surface, extending downwards for about an inch and a half, is triangular, with the base above and apex below; it is smooth and subcutaneous, while its anterior is covered with cartilage, and enters into the

formation of the greater sigmoid cavity, presently to be described. The coronoid process lies on a plane inferior and anterior to the last; it also is conical in form, slightly concave from above downwards, and exceedingly rough, for the attachment of the following parts: most superiorly, the anterior ligament of the joint; below this, the insertion of the brachialis anticus; then, the pronator radii teres; and still more inferiorly, the flexor digitorum sublimis, and a slip of the flexor pollicis longus. The great sigmoid cavity lies immediately above the last described process, forming a little more than one-third of a circle; it is concave from above downwards, convex from side to side, and presents in the centre a prominent vertical ridge, corresponding to the trochlea of the humerus, while a transverse depression is also sometimes found to exist, showing the point where the upper portion became united to the shaft. Situated on the outer and lower part of the greater sigmoid notch is the lesser, which is concave from before backwards, and deeper behind than in front, forming about one-fourth of a circle, for articulation with the head of the radius, the orbicular ligament completing the remainder of the ring for connecting the two bones together. The shaft of the bone is prismatic in its superior three-fourths, but rounded and contracted in its inferior, presenting for description three margins and three surfaces. Of these, the external margin is sharp and well-marked superiorly, where the interosseous membrane is attached, but gradually lost below, where this ligament ceases to exist. The anterior internal edge is the direct continuation downwards of the apex of the coronoid process, and is much more rounded than the external; while the posterior internal presents nearly the same characters as the last, stretching downwards from the olecranon process above to the styloid below. Of the three surfaces, the anterior is concave from above downwards, and slightly concave from side to side; its three superior fourths giving attachment to the flexor digitorum profundus, and its inferior to the pronator quadratus; near its upper part is the foramen for the nutritious artery, leading upwards towards the coronoid process. The internal surface is convex from above downwards, flat above, and rounded below; the flexor carpi ulnaris is connected to it by a strong aponeurosis for nearly its whole extent. The posterior surface, convex in its long axis, is divided by a vertical line into two parts, leaving a broad portion internally, and a narrower externally; to the one is attached the extensor carpi ulnaris; and to the other, if divided into five parts, to the superior, the anconeus; to the second, the extensor ossis metacarpi; to the third, the extensor primi internodii; to the fourth, the secundi internodii pollicis; and to the fifth, the indicator. The ulna, as already remarked, is much constricted below, and terminates

in two distinct processes; one external, called the head, the other internal, the styloid. The first of these is rounded and slightly expanded, covered with cartilage externally, to articulate with the sigmoid notch of the radius, and convex inferiorly, where it corresponds to the articular fibro-cartilage, which separates it from the cuneiform bone. Internal, and on a plane posterior to the head is the styloid process, about half an inch in length, and of the diameter of a crowquill; a well-marked groove, through which the tendon of the extensor carpi ulnaris glides, separates it on its posterior aspect from the head; it gives attachment by its blunted extremity to the internal lateral, and by its posterior surface to the posterior annular ligament.

The ulna articulates with two bones only, the humerus and radius, but at two distinct points with the latter. It is developed from three points of ossification: one for the shaft, and one for each extremity; that for the shaft being visible about the fortieth day, but those for the extremities not till the fifth and sixth year after birth. The union between the several parts is not completed till the eighteenth or twentieth year.

Radius.—This also belongs to the class of long bones, and is shorter, and not quite so strong as the last. For the purposes of description it may be divided into a head, neck, tubercle, shaft, and lower extremity. Of these the head is caliciform in shape, being slightly excavated, and covered with cartilage, to articulate with the capitulum of the humerus; it is surrounded by a rim of bone, also provided with cartilage, broader internally where it articulates with the lesser sigmoid notch of the ulna, than externally where it is embraced by the orbicular ligament. Below this point the bone presents an evident constriction for about an inch, as far in fact, as the tubercle; this is the neck, which does not observe the same axis as the shaft, but takes a direction upwards, backwards, and outwards. The tubercle, a small elevated process, is placed on the inner and anterior part of the bone, and is covered by a bursa, over which the tendon of the biceps glides, to be inserted immediately below it. The shaft of the bone, although prismatic in shape, like the ulna, differs from it, in having its more contracted part superiorly, and its broader and more expanded portion inferiorly. It presents for examination three surfaces, and as many margins; of these, the anterior surface is concave from above downwards, and flat from side to side, and has attached to its superior three-fourths, and internally, the flexor pollicis longus; to its middle third, and externally, the flexor digitorum sublimis; and to its inferior fourth, the pronator quadratus; near its upper and outer part is the hole for the nutrient artery. The external surface is convex from above downwards, and rounded;

having the supinator brevis inserted into its superior third, the pronator radii teres into its middle, where a well-marked crest appears for its attachment, and the supinator longus inferiorly, at the base of the styloid process where it is again rough for its reception. The posterior surface is likewise convex and rounded, giving attachment superiorly to the extensor digitorum communis; and inferiorly to the extensor ossis, and primi internodii pollicis. Of its three margins, the only one that is at all remarkable is the internal, which is sharp, and extends from about an inch below the tubercle to about two inches above the lower extremity of the bone, where it bifurcates into two ridges, forming the lips of the articulating facette called the sigmoid notch, for the extremity of the ulna; it gives attachment to the interosseous ligament. The lower part of the radius becomes broad and expanded, as contrasted with the shaft, and is directed slightly forwards and inwards, being concave on its anterior aspect, and presenting a very irregular, undulating lip, to which the anterior carpal ligament is attached, and over which the flexors of the forearm glide; externally it is prolonged into the styloid process, which is short, thick, and triangular; giving attachment by its point to the external lateral ligament; and by its posterior surface to the posterior annular. The posterior surface is convex and marked by a series of grooves, which may be thus described, viz.: one external, for the tendons of the extensor ossis and primi internodii pollicis; a second more internal, for the radial extensors; another still more internal, small but deep, directed downward and outwards, for the extensor secundi internodii pollicis; and internal to this is still a fourth channel, broad but superficial, through which the extensor communis and indicis glide to their insertion. The internal surface of the bone, as already remarked, is marked by a facette, concave antero-posteriorly, and covered with cartilage, for the reception of the head of the ulna; its lower border is sharp, and gives attachment to the base of the interarticular fibro-cartilage. The inferior extremity of the radius looks downward, forwards, and inwards; it is covered with cartilage, and presents two distinct facettes, both concave; the external, triangular, to articulate with the scaphoid; the internal, quadrilateral, to unite with the semilunar.

The radius is connected with four bones, viz.: the humerus above, the ulna laterally, and the scaphoid and semilunar below: it is developed from three points of ossification: one for the shaft, which is visible about the thirtieth day; another for the lower extremity, apparent about the second year, and a third for the upper, which is seen about the ninth. They are all united, forming a whole, about the twentieth year after birth.

Hand.—The hand, subservient to the functions which it is destined

by nature to perform, is endowed with an organization far more complex than the other parts of the body. To endue it with the varied motion which it possesses, we find that it is composed of a great number of bones, firmly bound together by powerful ligaments, and yet so arranged as to allow a certain degree of freedom, to adapt it to those offices which it is momentarily called on to perform. In order to render its structure more easy to be understood, anatomists have divided it into three distinct parts, viz.: the superior portion or carpus, consisting of eight small bones; the middle, or metacarpus, consisting of the five intermediate; and the inferior, or phalanges, constituted by the last fourteen.

The Carpus.—The assemblage of bones composing the carpus is arranged in two distinct rows,—each row consisting of four placed in the following order from without inwards, the scaphoid, semilunar, cuneiform, pisiform; and the second, in the same direction, are the trapezium, trapezoid, os magnum, and unciform. We will now proceed to give a brief description of each, beginning with the scaphoid.

Scaphoid.—This bone is very irregular in figure, being elongated from without inwards, and boat-shaped as its name implies; superiorly and externally, we observe on it an oval surface covered with cartilage, convex, and looking upwards, outwards, and backwards, for articulation with the radius; inferiorly, and internally, we find a large concave facette, looking downwards and forwards to receive the head of the os magnum; external to this, but still inferiorly, a smaller facette, of the same shape, but convex, to unite with the trapezuim, while the small ridge that separates the two discs looks downwards to articulate with the trapezoid: internally it presents a flattened surface, to articulate with the semilunar; externally it terminates in a rounded extremity, which gives attachment to the external lateral, annular ligaments, and the aponeuroses of the abductor opponens, and outer head of the flexor pollicis brevis; posteriorly it is rough and convex for the dorsal ligaments; while anteriorly, it is contracted and concave for the palmar. The scaphoid is thus seen to articulate with five bones: the radius, semilunar, os magnum, trapezoid, and trapezium.

Semilunar.—This bone, of the shape implied by its name, is broad posteriorly, convex, and rough, for the attachment of the dorsal ligaments, and thin anteriorly for the palmar; superiorly it is convex, covered with cartilage, and irregularly quadrilateral to articulate with the radius; inferiorly it presents two facettes, both concave and oblong from before backwards; the outer to articulate with the head of the os magnum, and the inner with the unciform; externally it unites with the scaphoid by a flattened, oblong facette, and internally

with the cuneiform by a triangular one. This bone, like the preceding, thus articulates with five—the radius, scaphoid, os magnum, unciform, and cuneiform.

CUNEIFORM.—This is a wedge-shaped bone with its broader surface turned posteriorly, and convex and rough for the attachment of the dorsal ligaments; the anterior edge being much smaller, but likewise irregular for the attachment of the palmar, and also presenting a circular facette for the pisiform bone. Its superior surface, rounded externally, grooved internally, is separated from the head of the ulna by the triangular fibro-cartilage, while its outer presents a flat quadrilateral facette, to articulate with the semilunar. Its inner border is free and blunted, and has inserted into it the internal lateral ligament, while its inferior has a long convex facette to articulate with the unciform; it is connected directly to three bones only, the semilunar, unciform, and pisiform.

PISIFORM.—Small and rounded like a pea, but very variable in size in different individuals. It is not placed exactly on the same plane with the three preceding bones, but rather on the anterior and internal aspect of the cuneiform, with which it articulates by an oval concave facette, affording attachment to the flexor carpi ulnaris, the abductor minimi digiti, and the anterior annular ligament. It articulates with one bone only, the cuneiform.

TRAPEZIUM.—The first bone of the second row is of an irregular cuboid figure, and as such presents six surfaces, which we will describe in order; the posterior, is semilunar and rough for the attachment of the dorsal ligaments; the anterior, is wedge-shaped; the sharp edge of the wedge, which looks directly forwards, giving attachment to the anterior annular ligament and abductor, opponens, and flexor pollicis brevis muscles, while internally is a deep groove, through which the tendon of the flexor carpi radialis glides. The superior aspect presents a circular concave facette, to articulate with the scaphoid; the inferior, a larger one, concave from before backwards, convex from side to side, for the extremity of the first metacarpal bone; a smaller facette being likewise visible on it inferiorly and internally, for the second; the external surface is rounded, and has inserted into it, the external lateral ligament; while the internal is concave from above downwards, and unites with the trapezoid. This bone is thus seen to articulate with four: the scaphoid, trapezium, and first, and second metacarpal.

TRAPEZOID.—A very small bone and rather wedge-shaped, its broader part, which is directed posteriorly, being of an oval figure, giving attachment to the dorsal ligaments, while anteriorly, it is contracted in size and rough, for the palmar. It articulates superiorly by a small concave surface, with the scaphoid; while inferiorly, it

presents a large oblong facette, concave from before backwards, and convex from side to side, for the second metacarpal bone; externally it is flat and triangular, where it unites with the trapezium; and internally, quadrilateral but still flattened, where it lies in contact with the os magnum. It thus articulates, like the preceding, with four bones, viz. the scaphoid, trapezium, second metacarpal bone, and os magnum.

Os Magnum.—This is the largest bone of the carpus, and has been divided into a head, neck, and body, this division being better marked on its posterior aspect, than on its anterior. The head, the highest part, is very convex, looks upwards, backwards, and outwards, and is received into a kind of socket formed by the union of the scaphoid and semilunar bones; while the neck is that constricted portion, lying immediately below it, and separated from it behind by a well-marked groove. Below the neck is the body, which is quadrilateral in shape, but much larger behind than in front; both surfaces are exceedingly rough, and give attachment, the posterior, to the dorsal ligaments, and the anterior, to the palmar, as well as to the inner head of the flexor pollicis brevis. The external border presents a small, smooth facette for the trapezoid; and the internal, a long, flat, vertical one, for the unciform, while inferiorly it presents three distinct surfaces covered with cartilage, and separated from each other by slight antero-posterior ridges, viz. a central one, convex and large for the third metacarpal bone; an external, concave, and smaller for the second; and an internal, extremely diminutive in size, for the fourth. The os magnum thus articulates with seven bones altogether, viz. the second, third, and fourth metacarpal, the trapezoid, scaphoid, semilunar, and unciform.

Unciform.—Conical in figure, with the base posteriorly, and apex anteriorly, terminating in that remarkable process from which it derives its name. Of an irregular quadrilateral form behind, it is rough for the attachment of the dorsal ligaments, while in front it presents the unciform process internally, which in shape resembles an incisor tooth, and which is convex and rough internally, but concave externally; it gives attachment to the flexor brevis minimi digiti, and to the anterior annular ligament of the wrist-joint; while from its root, but still anteriorly, the bone is prolonged upwards and outwards, for the origin of the adductor minimi digiti. Superiorly the unciform presents two facettes, a large one internally for the cuneiform, and another smaller externally for the semilunar. Inferiorly it has two articulating surfaces; the most external, large and oval in shape, for the fifth metacarpal bone; and the external, smaller and more circular, for the fourth. One facette only appears on it externally; this is long from above downwards, broader supe-

riorly than inferiorly for uniting with the os magnum, while internally it is thin and sharp, giving attachment to the internal lateral ligament. The unciform bone is thus seen to articulate with five: the magnum, semilunar, cuneiform, and two last metacarpal bones.

All these small bones are developed by single points of ossification, which become visible at different periods for each. Thus, it makes its appearance in the os magnum and unciform during the first year; in the cuneiform in the third; in the trapezium and semilunar in the fourth; and in the scaphoid and trapezoid in the eighth; while the pisiform is not ossified till the fifteenth year.

Metacarpal Bones are five in number, and belong to the class of long bones, each presenting two extremities, a carpal and phalangeal with an intervening shaft, the carpal ends being generally square in shape and expanded, and to a certain extent capable of being distinguished from each other by the number and shape of the facettes which appear on them. Thus, the first has only a single one on its extremity, which is concave transversely, and convex antero-posteriorly, but none laterally; while the second has four, three on its extremity, the central being the largest for the trapezoid, with two smaller ones on either side for the trapezium and os magnum, with one internally and laterally for the third metacarpal bone. Again, the third has only one facette on the extremity for the os magnum, with two lateral ones for the adjacent metacarpal bones; while the fourth has four, two superiorly, the smaller externally for the os magnum, the larger internally for the unciform; it also has two lateral ones for the contiguous bones. The fifth has only one superiorly for the unciform, and one externally for the fourth metacarpal bone. The carpal ends of the whole are rough anteriorly and posteriorly for the attachment of ligaments, and for the purpose of giving insertion to the following tendons, viz., to the posterior and external part of the first, the extensor ossis metacarpi pollicis; to the second, in front to the flexor, and behind to the extensor carpi radialis longior; to the third posteriorly the extensor carpi radialis brevior; to the fifth in front to the flexor, and behind, to the extensor carpi ulnaris. The shafts of all these bones are more or less constricted and prismatic in shape; they are convex posteriorly and concave anteriorly, while their sides are flattened for the attachment of the interossei muscles. In front they terminate in large rounded extremities, and articulate with the proximal ends of the first phalanges. If we now direct our attention to the differential characters of those several metacarpal bones, we will find them to be the following. The first, is known at once by its shortness and thickness, being also much flatter than any of the others. The third, is recognised immediately by its greater length, and although a striking similarity exists between the second and

fourth, still the former may be known without difficulty by the absence of the facette on its outer and lateral part. The identity of the fifth is established with facility, owing to its smaller size and slender character, as contrasted with the others.

The metacarpal bones are developed, each by two points of ossification, but occasionally three may be found. The ossific nodules do not make their appearance till the third year, if we except that of the first, which is visible in the sixth week, but the several parts do not become consolidated till the eighteenth year.

Phalanges.—These are fourteen in number; three for each finger, except the thumb, which has only two; all belonging to the class of long bones, and having a shaft with two extremities, a superior and inferior. Of these the superior, expanded from side to side, presents on its upper surface an oval concave facette, to articulate with the metacarpal bone, while on each side it has a tubercle, which is sometimes double for the attachment of the lateral ligaments. The shaft slightly constricted is convex and rounded posteriorly, where it is covered by the aponeurosis of the common extensor tendon; concave and flattened anteriorly, with a sharp lip at either side for the attachment of the fibrous sheath of the flexor tendons. Its inferior extremity, expanded from side to side, and curved forwards, presents anteriorly a double head or attempt at condyle, for articulation with the adjacent bone, which is also divided into two facettes to correspond with it. The second phalanges have precisely the same characters as those just described, but are shorter and smaller; while the third or distal differ from the others in their mode of termination, being thin and rounded anteriorly, smooth posteriorly, rough and crested at the point, and without a medullary canal which is present in the others. If we look now to the parts inserted into each, we will find them to be the following:—Into the base of the first phalanx of the thumb externally, the abductor and outer head of the flexor pollicis; internally, the abductor and inner head of the flexor pollicis; posteriorly, the extensor primi internodii pollicis; into the base of the last, anteriorly, the flexor pollicis longus; posteriorly, the extensor secundi internodii pollicis; while into the base of the first phalanx of the four outer fingers, the lumbricales and interossei are inserted; into the middle of the second, anteriorly, the flexor communis; and into the base of the third, the flexor profundus.

These several bones are developed each from two points of ossification, one for the upper extremity, and one for the shaft; but they are very variable as to their appearance, becoming visible from the first to the seventh year.

THE LOWER EXTREMITY.

The bones commonly said to enter into the formation of the lower extremity, are the two ossa innominata, the femur, patella, tibia, fibula, and foot. We will therefore commence our description with the first, and go through each of them in the order we have observed for those of the upper.

Os Innominatum.—Taken as a whole is hour-glass shaped, expanded at both extremities, and contracted and twisted inwards in the centre; but because in early life it was divisible into three distinct parts, viz., the ilium, ischium, and pubis, we will take each separately, and having examined them individually, will afterwards consider them as a whole, in the general review of the pelvis.

Ilium.—This forms by far the largest part of the bone, and may be separated from the other two by making a cut with a saw between the pubal eminence, and the anterior inferior spinous process, as far as, and a little above, the centre of the acetabulum. A second cut must now be made in the great sciatic notch, about an inch above the spine of the ischium, to meet the preceding one in the same cavity, and this will detach the ilium from the other two. On examining the bone thus removed, we find it to be fan-shaped, broad, and expanded above, thick and constricted below; the latter portion has been termed the body, and presents inferiorly between the two sawn surfaces on either side a central part, covered with cartilage, and forming a little less than two-fifths of the upper part of the acetabulum, looking downwards, forwards, and outwards; bounded above by an elevated ridge or lip, to which is attached the cotyloid ligament, while a little above it is the capsular, and still higher but more anteriorly, the outer head of the rectus. As we proceed still more superiorly, the bone becomes widely expanded, the term, *ala* being applied to it from its resemblance to the wing of a bird. This portion of the bone is convex anteriorly, concave posteriorly, and on it may be observed two or three large foramina, through which the nutritious branches from the glutæal artery enter the diploe. Three rough elevated lines are also observed on it; the first situated superiorly and posteriorly, commencing at the posterior fifth of the crest, and terminating midway between the two posterior spinous processes, giving attachment to the glutæus maximus. The second, is more in the centre, beginning a little behind the anterior superior spinous process, and stretching downwards and backwards as far as the upper part of the great sciatic notch, affording an origin to the glutæus medius. The third, is just above the edge of the acetabulum, commencing at the depression between the two anterior spinous processes, and likewise terminating at the lower part of

the great sciatic notch, and from it the glutæus minimus arises. The internal aspect of the ala, presents a broad concave surface, irregularly quadrilateral, smooth, but perforated by one or two holes, for the nutritious twigs from the ilio-lumbar artery; bounded above by the crest, below by the pectineal line, behind by the auricular facette for the sacrum, and in front by the two spinous processes, and the interval between them; this space is called the iliac fossa, which gives origin to the iliacus internus muscle. Immediately behind the iliac fossa, the character of the bone becomes completely altered, presenting anteriorly and superiorly an auricular surface, broad above and narrow below, marked by elevations and depressions, and covered with cartilage for uniting with the sacrum, while still more posteriorly it is irregular and rough, for affording attachment to the strong sacro-iliac ligaments. A small portion of the ilium is also found lying directly below the pectineal line, of a triangular shape, with the base turned posteriorly towards the sciatic notch, and the apex in front; it is flat and smooth, and covered by the pelvic fascia. If we now turn our attention to the circumferential margin of the ilium, commencing anteriorly and inferiorly, we will first observe a deep groove between the anterior inferior spinous process and pubal eminence; through which emerge the tendons of the psoas and iliacus muscles, with the anterior crural nerve lying between them. And as we ascend, we next meet with a well-marked prominence, the anterior inferior spinous process, from which arise the internal head of the rectus femoris, and accessory ligament of the hip-joint. Still higher up, we reach a depression or groove for the passage of the external musculo-cutaneous nerve; and highest of all an obvious eminence, the anterior superior spinous process, to the lower part of which is attached the sartorius; to its outside, the tensor vaginæ femoris, and to its apex Poupart's ligament. Proceeding from this point backwards, we come to the crest, extending as far back as the posterior superior spinous process. This is curved like an italic *S*, presenting anteriorly a convexity outwards, posteriorly a convexity inwards; thick in front and behind, but sharp in the centre, giving attachment by its outer and inner lips for its anterior three-fourths to the glutæus medius and iliacus internus; by its anterior two-thirds to the external oblique; by its whole extent to the internal oblique and transversalis; and by its posterior fourth to the glutæus maximus, latissimus dorsi, erectors of the spine, and quadratus lumborum. The crest terminates posteriorly in a sharp point, the posterior superior spinous process, to which is attached the ilio-lumbar ligament, and as we descend we observe a thin, sharp part of the bone for about an inch, till we reach the posterior inferior spine, which gives origin to the great sciatic ligament; again

curving from this point forwards, it becomes broad, rounded, and smooth, forming the upper and anterior part of the great sciatic notch, under which the glutæal artery, with its vein and nerve, passes outwards, sometimes grooving the bone, but nearly always throwing off in its course a large branch, which perforates the edge of the notch, near its posterior part, and, entering the diploe, establishes a remarkable anastomosis in the substance of the bone, with the ilio-lumbar, which pierces the wall of the iliac fossa to unite with it.

Ischium.—This portion of the bone may be detached from the pubis, by carrying the saw between the ascending ramus of the one and the descending of the other, so as to strike the junction of the upper with the middle third of the obturator hole. The cut having passed across this foramen, meets the edge of the acetabulum at the upper part of the notch, and, continuing its course inwards a little above the centre of this cavity, the bone in question becomes detached. The ischium has been compared in shape to a horse-shoe, and for the purpose of description may be divided into a body formed by the acetabular portion, a spine, tuberosity, and ramus. The body of the bone is very broad and thick, as contrasted with the other parts of it, forming something more than two-fifths of the acetabulum, and next to the ilium is its most prominent part, except internally where it is excavated, constituting what is called the notch, a natural deficiency left for the entrance of branches of the obturator and internal circumflex of the profunda, to enter to supply the parts lying within the capsular ligament. Immediately below the lip of the acetabulum, between it and the tuberosity, is a deep groove, traversed by the tendon of the obturator externus, and passing upwards, backwards, and inwards, in the direction of the spine; while behind the acetabulum, and between it and the spine, the bone is of a triangular shape, and slightly convex, over which the capsular muscles of the hip-joint glide to their insertion. The spine, situated posteriorly, directed downwards, backwards, and inwards; broad at its root, contracted at its free extremity, and forming the line of demarcation between the two sciatic notches, corresponds by its external surface to the pudic vessels and nerves, which glide over it, and affords attachment by its outer border to the superior gemellus; by its point to the lesser sciatic ligament; by its posterior part to the coccygæus; and by its internal surface to the levator ani. Anterior to the spine is a small but deep groove, directed outwards and backwards, which, in the natural state of the parts, is converted into a foramen by the great sciatic ligament crossing over it; this is the lesser sciatic notch, through which the pudic vessels and nerves enter, with a small branch from the sacral plexus, to supply the

obturator internus muscle which passes out, and is separated from the tuberosity of the ischium by a bursa. This last-named process, the tuberosity, irregularly triangular in shape, occupies the inferior part of the bone, and presents for examination two surfaces—an external and internal; and two margins—a superior and inferior. The external surface, very slightly convex, and perforated by one or two holes for the entrance of the nutritious vessels, gives attachment above to the obturator externus, and lower down to the adductor magnus; while the internal, comparatively smooth, affords origin, superiorly to the obturator internus, below and anteriorly, to the transversus perinæi, and still farther forwards to the erector and crus penis. Its superior margin, concave and sharp, forms the lower boundary of the obturator foramen, and gives attachment to the obturator membrane, while inferiorly it is triangular in shape, the base behind, the apex in front, convex from before backward, rough, looking downwards, backwards, and outwards, and gives origin superiorly and externally to the long head of the biceps; more anteriorly, to the semi-tendinosus; and external to both the semi-membranosus; still further inwards, above, to the inferior gemellus, and inferior to this to the quadratus femoris; the great sciatic ligament is also inserted into its inner lip, forming there its falciform process, which connects it to the triangular ligament and obturator fascia. The ascending ramus of the ischium is the connecting link between the tuberosity and pubis; of an oblong figure, and concave on its external surface antero-posteriorly, it gives origin internally, to the gracilis; in the centre, to the adductor magnus; and externally, to the obturator externus; while its inner surface, convex, affords attachment posteriorly to the obturator internus; more anteriorly, to the triangular ligament, and near its upper extremity, where it joins the pubis, to Guthrie's muscle or the compressor urethræ. Its posterior edge is sharp, and has connected to it the obturator membrane; while its anterior, rounded and twisted outwards, gives origin to the crus penis, and triangular ligament.

The pubis, which is already detached by the removal of the ilium and ischium, is of a triangular form, and may be divided into a body, horizontal ramus, spine, crest, and descending ramus. The body is constituted by the acetabular portion forming about one-fifth of that cavity, but the lip bounding it is much less prominent than those of the other two parts just described. Immediately above and anterior to it is a large expanded eminence, known as the pubic, bounding internally the groove for the psoas and iliacus to play through, into which the lesser psoas is inserted; and as we proceed forwards and inwards, we reach the horizontal ramus, extending from this point as far inwards as the spine; the anterior part

of its superior surface is surrounded, giving origin to the pectineus muscle; while more posteriorly, as a sharp, elevated ridge, appears the linea innominata, which affords attachment to the following parts, viz., to Gimbernaut's, Hey's, and Colles' ligaments, and the conjoined tendons, as well as to the iliac and pubic portions of the fascia lata of the thigh, and the fascia iliaca. The inferior aspect of the horizontal ramus corresponds to the obturator foramen, and is here deeply grooved from without downwards, forwards, and inwards, for the passage of the vessels and nerves of the same name; anteriorly, it presents nothing remarkable, being only flattened and expanded at each extremity, rounded and constricted in the centre; while posteriorly, it is also flattened and broad, and is covered by the pelvic fascia. At the termination of the horizontal ramus, anteriorly and superiorly, is the spine, of variable size, directed upwards, backwards, and outwards, giving insertion to Poupart's ligament and the cremaster muscle, and likewise corresponding to the base of the external abdominal ring. The crest is that portion of the bone intercepted between the spine and angle, about an inch in length, rounded, and covered with cartilage, giving attachment to the flat abdominal muscles, rectus, and pyramidalis, while the symphisis, placed internally, and descending nearly vertically from the crest, is covered with cartilage, and cut off obliquely from before, backwards, and inwards, in such a manner that while the lips of the bones of opposite sides are nearly in contact posteriorly, they are separated by a broad interval anteriorly, which is filled up with a dense fibro-cartilage for their better security, while below the symphysis is the edge of the descending ramus, bent outwards, affording attachment to the arched subpubic ligament. The anterior surface of the descending ramus, by some called the crest, is flattened and quadrilateral in front, giving origin, between the spine and angle, to the adductor longus; between the spine, angle, and thyroid foramen, to the adductor brevis; while stretching downwards, in the centre, for nearly its entire length, to the adductor magnus, and between it and the symphysis, to the gracilis; its posterior aspect is much smoother and more convex, and affords attachment from above downwards to the pelvic fascia, levator ani, and Wilson's muscles; externally and posteriorly it is sharp, and forms the anterior boundary of the thyroid hole; while inferiorly, it becomes continuous with the ascending ramus of the ischium.

The os innominatum, taken as a whole, is developed from eight points of ossification, of which three are primitive, and five complementary. The three primitive, are for the three separate pieces of bone, and are visible in the following order:—That of the ilium, about the second month; that for the ischium, about the third; and

that for the pubis, about the fifth; these several portions not, however, being united fully till the fifteenth year. The complementary points are, one for the crest of the ilium; one for the tuberosity of the ischium; one for the anterior superior spinous process; one for the angle of the pubis; and one for the centre of the acetabulum.

The pelvis, thus constituted by the ossa innominata, the sacrum, and coccyx, forms a whole, remarkable not only for its great strength, but likewise for its extreme lightness. Placed not perpendicularly, but obliquely, owing to the saliency of the sacro-vertebral angle, with its superior outlet looking upwards and forwards, and its inferior downwards and backwards, it is admirably adapted not only to break the force of sudden shocks, which being transmitted along the vertebral column, might otherwise have been attended with danger to the nervous centres, but also to confer security on the contents of the abdomen, by throwing them forwards on the arch of the pubis, and so preventing them from pressing too heavily on the less solid structures which complete its inferior aperture. When we examine the interior of the pelvis, we are struck at once by a prominent ridge which is observed encircling it about its centre; constituted by the pectineal lines laterally, the upper part of the crest of the pubis anteriorly, and the sacral promontory posteriorly. Anatomists have taken advantage of this fact to divide the pelvis into two great parts, terming all above the ridge *the false pelvis*, and all below it *the true;* the former being by far the larger and more expanded of the two, looking upwards and forwards, and bounded in the following manner—behind by the last lumbar vertebra; laterally by the alæ of the ossa ilii; and in front, as no osseous structure exists, by the abdominal muscles, stretching across between wing and wing. During life, the false pelvis is filled up by the iliac and psoæ muscles, the cœcum, sigmoid flexure, and external iliac arteries; and after death, distinctly affords a good indication of the difference of sex, being broad and expanded in the female, while in the male it is relatively smaller and more contracted—a condition still more strikingly obvious in infantile life. The true pelvis, on the other hand, is much smaller than the last described, is of an oval figure, broader from side to side than from before backwards, bounded anteriorly by the symphysis pubis and the back part of its descending rami; laterally by the ischium, and those portions of the pubis and ilium entering into the formation of the acetabulum; and posteriorly by the anterior surface of the sacrum and coccyx. The outline of its upper aperture is entirely osseous, presenting that horizontal line already alluded to as separating it from the false pelvis, and looks upwards and forwards; while that of the inferior, directed downwards and backwards, is very irregular, owing to the

deficiency existing anteriorly between the rami of the ischium and pubis, as well as similar ones laterally and posteriorly, known as the sciatic notches. Here again a striking difference is visible in both the configuration and size of the true pelvis in the male and female, as in the one it is contracted in its circumferential measurements, but deep from above downwards; while in the other, on the contrary, its diameters, both conjugate and transverse, are much more extensive, but it is shallow from above downwards, these differences naturally depending on the functions which the opposite sexes are called on to perform in the offices of procreation. The true pelvis in the male, contains the bladder in front, with the rectum behind; and in addition, the prostate gland, vesiculæ seminales, terminations of the ureters, vasa deferentia, sacral plexus of nerves, internal iliac arteries, with their branches, levatores ani, pyriformis, and obturator internus muscles; while in the female, besides the bladder and rectum, it has the uterus, with its broad ligaments, containing the round ligament, ovaries, and Fallopian tubes, with the several nerves, arteries, and muscles already enumerated in that of the male.

In undertaking the examination of the exterior aspect of the pelvis, it is always the better plan to divide it into four regions, viz., an anterior, posterior, and two lateral. Of these, the anterior region, may be said to occupy that space intercepted between two vertical lines drawn between the pubic eminence above, and the anterior part of the tuberosity of the ischium below; in this space we may observe two well-marked arches; a superior, with its pillars constituted by the horizontal rami of the pubis, each supported by the acetabulum on either side; and an inferior, with its pillars formed by the rami of both ischium and pubis, and terminating at the tuberosities. A triangular interval, broader in the female than in the male, for obvious reasons, separates the pillars of the inferior arch, but in the natural condition of the parts, filled up above by the subpubic, and below by the triangular ligament; these structures, stretching tensely across, serving to give a greater security to the arch, and conferring lightness, while allowing a passage for the important parts which must pass through it to reach their ultimate destinations. External to this arch, we have another deficiency in the pelvic wall, known as the obturator foramen; of an oval shape, broader above than below, bounded internally, inferiorly, and externally by the ischium; superiorly by the pubis, in its natural state it is completed by the obturator membrane, a strong tense process of fibrous tissue which fills it up altogether, except superiorly, where an oblique canal is left patulous, directed downwards, forwards, and inwards, for the transmission of its own artery, nerve,

and vein; in this instance again nature having added considerably to the lightness of the bone, without detracting materially from its strength.

The lateral region of the pelvis is that portion intercepted between the pubic eminence and anterior part of the tuberosity of the ischium in front, and the edge of the sacrum behind. It presents superiorly and anteriorly the acetabulum formed by the proportions of the several bones already enumerated; the free border of this cavity not exhibiting an horizontal plane, but being prominent superiorly opposite the ala of the ilium; depressed posteriorly at the junction of the ischium with the last-named bone; again prominent opposite the tuberosity; excavated into a deep notch at the thyroid foramen; elevated at the pubic eminence, and again depressed a little posterior to this process. The acetabulum is a deep and cup-like concave depression, covered with cartilage of incrustation, except inferiorly and internally opposite the notch, where it is completely deficient; this deficiency constituting about one-fourth of the whole, and in figure resembling the ace of spades, while the aspect of the whole cavity is downwards, forwards, and outwards, to articulate with the head of the femur. Below and behind the acetabulum, we have the tuberosity, a well-marked process, which supports the body when in a sitting position; it is exceedingly rough in its character for the attachment of those muscles already mentioned in the description of the separate bone. Behind the tuberosity, is the excavation for the lesser sciatic notch, which is converted into a foramen by the greater sciatic ligament passing over it, the foramen so formed being traversed by the obturator internal muscle, its nerve with the pudic vessels and nerve. Still more posteriorly is the greater sciatic notch, bounded anteriorly by the ischium, superiorly by the ilium, posteriorly by the sacrum, and inferiorly by both greater and lesser sciatic ligaments. This large excavation is for the purpose of allowing the pyriformis muscle to emerge from the pelvic cavity, this muscle, in fact, dividing it into two distinct parts, an upper and lower, through the one of which pass the gluteal vessels and nerves, and through the other the pudic and sciatic arteries, with all the external branches of the sacral plexus. The appearance of the posterior region having been already noticed in the description of the sacrum and coccyx, requires no further comment, and it therefore only remains for us to offer a few remarks with respect to the pelvis in early infancy, when it presents the following peculiarities:—It is much more oblique, its superior aperture looking almost directly forwards, and so extremely contracted in all its dimensions as to be incapable of containing the bladder, which at this period lies in the lower part of the abdomen. Its alæ likewise are nearly perpendicular and

straight; the sacrum also straight and narrow, while the horizontal rami of the pubis are exceedingly short, this latter fact giving rise to that peculiar position of the acetabula, which at this early age are placed more anteriorly than they are in adolescence, being at the same time remarkably shallow. In the later stage of life the pelvis again becomes very oblique, but this change in position is the gradual effect of that general debility consequent on the impaired vital functions inseparably connected with our declining years.

FEMUR.—This is a long bone, and the largest and strongest of its class in the whole human body; presenting for examination a head, neck, greater and lesser tuberosities, shaft, and two condyles. Commencing with the head, we find it to be globular, forming about three-fourths of a sphere, and covered with cartilage, except at a a point inferior and posterior to the centre, where a deficiency exists for the attachment of the ligamentum teres. An irregular wavy line, which may be termed the *anatomical neck*, separates it from a part of very great importance, known as the surgical neck; this is of a triangular figure, with its truncated apex above continuous with the head, and its base below and without, limited by two ridges; the one anterior, long, but badly marked, the anterior intertrochanteric line, to which the capsular ligament is attached; the other posterior and exceedingly prominent, the posterior intertrochanteric line, affording insertion to the quadratus femoris. The axis of the neck is oblique, being directed upwards, forwards, and inwards, and forming an obtuse angle with the shaft; it is concave on its upper surface, to permit the lip of the acetabulum to lodge in it in motions of extreme abduction; rounded inferiorly, where we find a thick lamina of compact tissue for the purpose of conferring strength; flattened anteriorly and short, but longer posteriorly and slightly concave, where it gives insertion to the capsular ligament: several foramina for the passage of the nutritious vessels being visible on this surface towards its lower part. The vertical diameter of the neck is invariably much greater than that of its antero-posterior, an important provision of nature for the purpose of giving strength to the bone, in that direction in which fracture would be most liable to occur from the superincumbent weight of the body. On the upper and posterior part of the neck, near its outer extremity, is a deep depression, bounded externally by the great trochanter, called the digital fossa, which gives insertion to the capsular muscles in the following order:—Most superiorly to the pyriformis; then to the superior gemellus; then to the obturator internus; then to the inferior gemellus; and lastly, to the obturator externus. The great trochanter, placed on the outer and upper part of the shaft, is quadrilateral in

shape, higher posteriorly than anteriorly, and inclined inwards, so as to overlap the neck; it is rough externally, and covered by a large bursa, over which the glutæus maximus glides; while on its upper edge are two facettes, the more posterior for the insertion of the glutæus medius, and the more anterior for that of the glutæus minimus. The lesser trochanter, much smaller in size and conical in shape, is situated on the internal and posterior part of the bone on a plane inferior to the greater; its apex is rounded, and also covered by a small bursa, over which the conjoined tendons of the psoas and iliacus glide, to be inserted into its root inferiorly; anteriorly at its junction with the shaft, there is a rough concave depression, for the insertion of the accessory ligament of the hip-joint, while posteriorly it gives origin to the vastus internus. The shaft of the bone is cylindrical in shape, expanded above and below, contracted in the centre, and twisted inwards inferiorly; it presents for examination four surfaces—an anterior, internal, external, and posterior. Of these, the anterior convex from above downwards, and rounded from side to side, but rather flat superiorly and inferiorly, gives attachment by its superior three-fourths to the cruræus, and by its inferior fourth to the subcruræus. Externally the bone is nearly straight, affording origin to the vastus externus for its whole length, while internally it is concave, and has the vastus internus attached to it. Its posterior surface, also concave, presents in its middle third an elevated ridge or crest, the linea aspera, with its upper extremity bifurcating into two roots; a long one externally, which connects it to the great trochanter, and a shorter one internally, which unites it to the lesser; to the first are attached, from without inwards, the vastus externus, glutæus maximus, and adductor magnus; and to the second, from within outward, the vastus internus, pectineus, and adductor brevis. The linea aspera itself presents two lips; an external, affording attachment to the vastus externus, and glutæus maximus, with the short head of biceps, the latter muscle arising where the insertion of the former terminates; while its internal has connected to it, the vastus internus, and adductor longus and magnus. Its inferior extremity likewise bifurcates into two roots: an external, rough, and well-marked, terminating at the external condyle, and giving attachment to the vastus externus and biceps; and an internal, only visible above and below, but smooth in the centre for the femoral artery to glide over it, and running to the inner condyle, has connected to it the vastus internus and adductor magnus. At the inner side of the linea aspera, a little below the centre of the bone, is seen the large hole, which is sometimes double, for the nutritious artery to enter, taking a direction upwards and forwards. The lower part of the femur continues to increase gradually in size till it

terminates in the two condyles; it becomes exceedingly cellular in structure, broad and concave anteriorly, perforated by several foramina, and sometimes covered with a bursa, over which the subcruræus glides. Posteriorly, it is flattened and triangular in figure, corresponding to the poplitcal region, and presenting two roughened spaces immediately above each condyle, for the origin of the plantaris and outer head of the gastrocnemius externally, and for the inner head of the latter muscle internally, while on its outside and its inside, where it is still much expanded, it is covered by the aponeurosis of the two vasti. The two condyles which occupy the inferior extremity of the femur, are extremely large and prolonged backwards, separated from each other by a depression in front, the intercondyloid space, which is broad, concave, and covered with cartilage for articulation with the patella; a similar space, the posterior intercondyloid, likewise exists posteriorly, but much deeper and narrower, not covered with cartilage, and in the natural condition of the parts filled with fat, affording insertion to the crucial and mucous ligaments. On contrasting the two condyles with each other, they are found to present the following differences; the internal is thinner, longer, and proceeds much farther backwards; while the external is much thicker, advances prominently forwards, and is covered with cartilage much higher up. On the outer side of the last named, inferiorly and posteriorly, is situated a small eminence for the attachment of the external lateral ligament, and beneath it is a groove for the origin of the poplitæus muscle, while internally it is rough for the insertion of the anterior crucial ligament. A much larger tubercle is visible on the inner side of the internal condyle, and to it is attached the adductor magnus above, and the internal lateral ligament below, while its outer surface is also rough for the insertion of the posterior crucial ligament.

The femur articulates with three bones, viz., the os innominatum above, and the tibia and patella below, and is developed from five points of ossification, of which three are primitive; one for the shaft, apparent about the sixth week; one for the lower portion, visible about a fortnight before birth; and one for the head, which is not developed till a year after birth. The two complementary points are for the greater and lesser trochanters; that for the first making its appearance about the fourth; and that for the second about the twelfth year. All those separate points, are united about the age of twenty.

There are certain modifications existing in the upper part of the femur, dependent on both sex and age, to which it is necessary to make a brief allusion. Thus in the fœtal bone, the neck is a mere extension of the shaft, both forming nearly a continuous line; while

in the female, on the contrary, it is longer, narrower, and placed more at a right angle with the shaft; in old age it is shortened considerably, is much weaker, and as in the female, springs at nearly a right angle from the bone. When we make a longitudinal section of the neck of the femur, we observe that it is cellular in its character; except inferiorly, where a dense arch of compact tissue passes upwards and inwards to the head. In old age, from the effects of interstitial absorption, a change takes place which enlarges the cells, and at the same time renders the compact tissue more porous, producing that liability to fracture, so peculiar to this period of life, the result in fact of diminished cohesion.

PATELLA, or, as it is sometimes called, Rotula, from being developed in the tendon of the rectus muscle, belongs to the class of sesamoid bones, though it may be said to differ from sesamoid bones generally, both from its greater size, and from its being found on the angle of extension, and not of flexion, as the others of the same description invariably are. In its outline it is heart-shaped, presenting for examination an anterior and posterior surface, an internal and external margin, with a base and apex. The anterior surface, rough, convex, and marked by a number of vertical lines or striæ, is covered by a dense fibrous structure, derived from the tendon of the rectus, and fascia lata of the thigh; while the posterior, has a vertical ridge in the centre, corresponding to the trochlea of the femur, and dividing it into two portions, both covered with cartilage; the external, the larger, to articulate with the outer condyle; and the internal, the narrower to articulate with the inner. Its base which is turned upwards is flattened and thick, affording attachment to the rectus and cruræus, while its apex which is turned downwards has the ligamentum patellæ connected to it Both its inner and outer border are convex and sharp, and give insertion, the one to the vastus internus, and the other, to the vastus externus—those muscles with the rectus and cruræus being known as the quadriceps extensor cruris.

The patella articulates with the femur only, and is developed from a single point of ossification, which is visible between the second and third year.

TIBIA.—This is another of the class of long bones, coming next after the femur in size and strength, and presenting for examination a shaft with an upper and lower extremity. Taking first its upper extremity, we find that it presents superiorly, two articular facettes for the condyles of the femur; both covered with cartilage, but differing from each other in the following particulars: while the internal is oval from before backwards, and deeply concave, looking upwards, backwards, and inwards, the external is comparatively flat,

more circular in figure, and looks upwards, backwards, and outwards. These articular facettes are deepened, for the reception of the condyles of the femur, by the semilunar cartilages which surround them, and are separated from each other, by an irregular crest of bone, extending from before backwards, and inclined upwards and inwards, termed the spine; anterior, and posterior to which, is a pit or depression for the attachment of the crucial ligaments, and cornua of the semilunar cartilages. The anterior part immediately below the head of the bone is of a triangular shape, with the base above and apex below; the latter formed by an elevated process called the tubercle, into which the ligamentum patellæ is inserted; the surface alluded to, being rough, and perforated by several foramina for the nutritious vessels to enter, while it corresponds to the Haversian gland, which separates it from the ligamentum patellæ. The posterior part on the other hand is flattened; and covered by the ligamentum posticum of Winslow. Posteriorly and externally, we observe a circular facette looking downwards, backwards, and outwards, to articulate with the fibula; and still more anteriorly a rough space, for the insertion of the second slip of the external lateral ligament; while on the inner part may be observed a deep channel or groove, leading from behind forwards, for the tendon of the semi-membranosus, this muscle being attached to its anterior and lateral part, immediately beneath the internal lateral ligament. Proceeding now to the shaft, we find it to be prismatic in shape in its four superior fifths, but quadrilateral in its inferior, and twisted slightly outwards. It accordingly presents three margins, viz.: an anterior, external, and internal, with as many surfaces. Of these, the anterior, more commonly known as the crest, or shin, commences above at the tubercle, and passing downwards in a wavy line, which is very sharp in the centre, terminates at the inferior fourth, where it becomes flattened out and gradually lost in the smooth surface below. The external margin, not so prominent as the preceding, begins above, a little anterior to the facette for the fibula, and extends downwards until it arrives at a point about two inches above the inferior extremity of the tibia, where it bifurcates to form the anterior and posterior lips of the groove, for the fibula; to this margin is attached the interosseous ligament. The internal edge, badly marked, reaches from the head down to the back part of the internal malleolus, and gives attachment to the deep fascia of the leg. Of its three surfaces the internal is by far the smoothest, being slightly convex above, and concave below; into it immediately below and behind the tubercle the sartorius is inserted; a little lower, and still more posteriorly, the gracilis; and still more inferiorly and posteriorly the semi-tendinosus: while in the rest of its extent it is subcutaneous. The external sur-

face, concave above, and convex below, gives attachment by its two superior thirds to one muscle only, the tibialis anticus; while the posterior, comparatively flat, has in its superior fifth the popliteal ridge, extending downwards and inwards; into which, as well as into the space above it, is inserted the muscle of the same name; below and internal to this line is the hole for the nutritious artery; and for a distance of two inches lower than this point arises the inner head of the solæus, external and inferior to which, and occupying a variable space, is the origin of the flexor digitorum communis. In its inferior fifth, the bone becomes of a quadrilateral figure, presenting four surfaces,—an anterior, posterior, external, and internal. Of these the anterior is rounded and smooth, for the extensor tendons to glide over, giving attachment by its inferior lip, to the anterior ligament of the ankle joint; its posterior surface is much flatter; and on it, may be observed two remarkable grooves, both extending downwards and inwards, the internal exceedingly deep for the tendons of the tibialis posticus and flexor communis; the external not so well marked for the passage of the tendon of the flexor pollicis longus. The external surface presents a triangular notch, with the base below and the apex above, for the reception of the lower end of the fibula; while the internal is prolonged into a quadrilateral process known as the internal malleolus, smooth on its inner part where it can be felt beneath the skin and fascia, covered with cartilage towards the joint where it articulates with the astragalus, rough and prolonged anteriorly, for the attachment of the anterior annular ligament; but thicker and shorter posteriorly, where it affords insertion to the posterior annular, and inferior tibio-fibular ligament. The lower extremity of the tibia is quadrilateral in shape, convex from side to side, concave from before backwards; the convexity alluded to being due to a ridge which traverses it in an antero-posterior direction, dividing it into two facettes, the external of which is oblong in shape, with its long measurement from before backwards, while the internal, more quadrilateral, is bounded internally by the articular surface of the internal malleolus. The posterior lip of bone which bounds the astragaloid surface of the tibia inferiorly, is longer than the anterior, for the obvious purpose of preventing displacement forwards of the tibia in progression, a movement to which it is naturally inclined, while the position of the internal malleolus on a plane anterior to the external is as obviously calculated to increase the basis of support for the body by the eversion of the toes thus produced.

The tibia articulates with three bones only, viz., the femur above, the fibula laterally, and the astragalus below; and is developed from three points of ossification: one for the shaft, which appears

about the sixth week; one for the lower, and one for the upper extremity; both of the latter being visible from the first to the second year; a fourth complementary point occasionally may exist for the tubercle. The union of all these several parts is not completed till the twentieth or twenty-first year.

Fibula.—Is the most slender of all the long bones, and placed in the leg, not for the purpose of bestowing support, but to afford a broader basis for the attachment of muscles, and to complete that peculiar mortice-joint of which the ankle presents an example. Like all others of the same class, it may be divided into a shaft, an upper extremity called the head, and a lower termed the external malleolus. In directing our attention to the head, we find it to be of a conical figure, presenting superiorly and posteriorly, a pointed process, into which is inserted the tendon of the biceps, and the external lateral ligament; while internally and anteriorly it is covered with cartilage, and looks upwards, forwards, and inwards, to articulate with the tibia, being rough anteriorly and posteriorly for the attachment of the tibio-fibular ligaments. The shaft, irregularly prismatic in shape, presents an anterior well-marked edge, which gives attachment to the intermuscular septum placed between the muscles connected to the external and anterior part of the bone; it stretches from the neck above down to within two or three inches of the malleolus, where it bifurcates into two ridges, one of which forms the anterior, and the other the posterior boundary of that process. The internal margin, also prominent, but deficient in its superior and inferior fifths, affords attachment to the interosseous ligament; while the external may be said to exist only in its inferior four-fifths, and has connected to it the deep fascia of the leg. Of its three surfaces, one is internal and anterior, concave, and traversed from above downwards by a vertical ridge that divides it into two parts; to this surface is attached for its three superior fourths the extensor digitorum communis; for its middle third, but on a plane posterior to the last, the extensor pollicis; and for its inferior half, but anterior to the other two, the peronæus anticus. The external surface, rounded and slightly convex, gives origin by its upper third to the peronæus longus, immediately below it to the peronæus brevis, while still lower down the bone is subcutaneous. The posterior surface contracted above, expanded in the centre, and again constricted below, has connected to it the long head of the solæus superiorly; to its inner margin for a great part of its length, the tibialis posticus, and more externally for its inferior two-thirds, the flexor pollicis longus. The lower part of the bone gradually expands into a process called the external malleolus, which is of conical shape, with the point of the cone turned downwards and backwards; it is thick, rounded,

and subcutaneous externally, and fitted closely into the groove of the tibia internally and superiorly, but flattened and covered with cartilage lower down, where it articulates with the outside of the astragalus; its anterior border comparatively sharp and prominent affords attachment to the anterior slip of the external lateral and anterior annular ligaments, while its inferior posterior is broad and grooved for the tendons of the peronæi; its extremity, sharp and pointed, gives origin to the posterior slip of the external lateral ligament; it is hollowed out internally for the middle slip of the same ligament, while it is subcutaneous externally.

The fibula articulates with two bones only, the tibia and astragalus, and is developed from three points of ossification, viz., one for the shaft which is visible about the seventh or eighth week, one for the upper portion, which appears about the fifth year, and one for the lower extremity, which may be seen about the second ; the whole becoming united from the twentieth to the twenty-fifth year.

The Foot.—This portion of the skeleton, exactly as in the hand, is composed of several bones of different sizes, united firmly to each other by powerful ligaments ; but as it is destined to support the weight of the whole trunk, it is natural to expect that the osseous parts entering into its formation should be on a much larger and stronger scale than those in the hand, the function of which is simply prehension. To adapt the hand to this office we accordingly find that the phalanges are exceedingly long, while in the foot they are comparatively short; the contrast still continues in the metacarpal and metatarsal bones, but in a reversed manner, those of the hand being remarkable for their shortness and lightness, while the others are lengthened and strong, for supporting the body and enabling us to maintain with security the upright position. But it is in the carpus of the one, and the tarsus of the other that the most striking difference may be observed, the bones of the first being remarkable, with one single exception, for their diminutive size and for the delicacy of their contiguous surfaces; while those of the second are as distinguished for their magnitude, and for the broad facettes by which they are united to each other.

Anatomists have divided the foot into three distinct parts, viz., the tarsus, comprising the astragalus, os calcis, navicular or scaphoid, cuboid, and three cuneiform bones ; the metatarsus consists of five distinct bones ; and the phalanges of fourteen, the great toe, like the thumb, being deficient in one. We shall now proceed to describe each in the same order as we have enumerated them, commencing with the astragalus.

Astragalus.—Belongs to the class of round or irregular bones, and is placed the highest in the tarsus. In shape it is rather cuboid,

and presents for examination two surfaces, a superior and inferior; two sides, an internal and external; and two extremities, an anterior and posterior. On examining its superior surface we observe on it a large facette, covered with cartilage, looking upwards, backwards, and inwards; convex from before backwards, and concave from side to side; limited behind by a superficial groove, to which is attached a thin layer of areolar tissue, by some described as the posterior ligament of the joint; bounded anteriorly, by a depression much broader, termed the neck, which is perforated by several foramina for the nutritious vessels, and affords insertion to the anterior ligament, and also by its outer edge to the anterior slip of the external lateral; internally and externally it is circumscribed by two elevated lips of bone, that on the outer side being the more prominent, and the whole facette, much wider in front than behind, articulates with the lower extremity of the tibia. The inferior surface of the bone, larger than the superior, is marked by two facettes; one posterior and external, oval in shape, concave, looking downwards, forwards, and inwards; the other anterior and internal, likewise of an oval figure, and slightly convex, looking directly downwards, and much smaller than the other, both covered with cartilage to articulate with corresponding surfaces on the os calcis; a deep sulcus leading from within, forwards, and outwards, much more expanded externally than internally, separates them, and gives attachment to the powerful interosseous ligaments that unite the bones together. The external margin, very irregular in its character, presents an articulating surface for the external malleolus, triangular in shape, with the base above and apex below; concave from above downwards, and slightly convex from before backwards; while anteriorly it is scooped out, and forms a deep depression, corresponding to the side of the neck of the bone. The facette on the internal margin, for the internal malleolus, differs both in size and shape from the preceding, being much smaller, auricular in form, and a little convex; it is bounded below by a wavy groove, studded with foramina for the entrance of the nutritious vessels; in front it becomes directly continuous with the neck, while below and behind it is the ridge for the insertion of the posterior portion of the internal lateral ligament. The anterior extremity of the bone presents a well-marked convex process, called the head, forming about one-third of a sphere, but oval in shape, long from above and without, downwards and inwards, and covered with cartilage to articulate with the scaphoid, while its posterior extremity terminates in a well-marked tubercle, internal to which is a deep groove, directed downwards and inwards, through which the tendon of the flexor pollicis glides.

The astragalus articulates with four bones, viz., the tibia above

and internally, the fibula externally; the os calcis below, and the scaphoid in front. It should, however, be recollected that it has six facettes, as both the tibia and os calcis unite with it at two distinct points.

Os Calcis.—This likewise belongs to the class of round bones, is the largest of all those constituting the tarsus, and lies immediately inferior to the last described. It is of an oblong shape, presenting four surfaces; a superior, inferior, external, and internal; and two extremities, an anterior and posterior. The superior surface, for its two anterior thirds, is marked by two facettes to articulate with those of the astragalus; one anterior and internal, supported by a peculiar process, the sustentaculum tali, oval in shape and concave; the other larger, of the same figure, but convex, both covered with cartilage, and separated by a sulcus, shallower than that which we observe on the astragalus for the interosseous ligaments; while farther back the bone is prolonged into a process, called the calx, or heel. The inferior surface, comparatively narrow, presents behind, two tubercles for the origin of the strong plantar fascia, and first layer of plantar muscles, viz., the abductor pollicis internally, the abductor minimi digiti externally, and the flexor digitorum brevis in the centre. As we proceed still forwards, we find the bone becoming rough and rounded, giving attachment on either side to the forked head of the musculus accessorius, and between them to the superficial portion of the calcaneo-cuboid ligament; while still more anteriorly, there is another tubercle, but badly marked, to which is connected the deeper portion of the calcaneo-cuboid ligament, and outer head of the flexor pollicis brevis. The external surface is broad posteriorly, but narrow anteriorly, having a little behind its centre a tubercle for the insertion of the middle slip of the external lateral ligament, a superficial groove being occasionally visible at the same point for the peronæi tendons, while all the remainder of it is subcutaneous. The internal surface presents a well-formed arch, constituted principally by the sustentaculum, the inner margin of which is grooved; into the lips of this groove is inserted the middle slip of the internal lateral ligament, while over its insertion the tendons of the tibialis posticus, and flexor digitorum communis glide to their insertion. By the junction of this process with the side of the bone, a deep sulcus is formed, continuous with the groove on the back part of the astragalus; through this the tendon of the flexor pollicis longus passes, with the posterior tibial artery, veins, and nerve lying immediately internal to it. Directing now our attention to the posterior extremity of the bone, we find it to be ovoid in figure and convex, smooth above where a bursa rests on it, but rough inferiorly, where the tendo Achillis, and plantaris are in-

serted into it. Its anterior extremity on the other hand is much more contracted in size and covered with cartilage, is concave from above downwards, convex from side to side, and cut off obliquely from without backwards and inwards, for articulation with the cuboid.

The os calcis articulates with two bones only, viz., above by two points, sometimes three, with the astragalus, and in front with the cuboid.

Scaphoid.—This bone has received its name from its shape, resembling in some measure a boat or canoe, but strictly speaking it is of an ovoid figure, broad superiorly and externally, but narrow and pointed inferiorly and internally, presenting for examination a posterior, and anterior surface, with a circumference. Of these, the posterior surface, is oval and slightly concave, and covered with cartilage, to receive the head of the astragalus; while the anterior is irregularly convex, and marked by three facettes, of which the internal is the largest and triangular in shape, with the apex above, the base below, and convex from above downwards, for articulating with the internal cuneiform. The second or middle, is also triangular, but its base, which is situated superiorly, is broader than that of the first; it is also shorter from above downwards, not so convex, and unites with the middle cuneiform; while the third or external is similar to the last described in appearance, but intermediate in size between it and the first; it articulates with the external cuneiform. If we look now to the upper part of the circumference we will find it to be rough and convex, for the attachment of the dorsal ligaments connecting it to the adjacent bones; the internal surface is much flatter, and gives insertion to the anterior slip of the internal lateral ligament, while the external sometimes presents an articular facette for the cuboid, but this is not always manifest. Inferiorly and internally, the bone terminates in a sharp-pointed process, for the attachment of the tibialis ~~anticus~~, and calcaneo-scaphoid ligament.

The scaphoid articulates with four bones as the rule, viz., the astragalus posteriorly, and the three cuneiform anteriorly; occasionally also with the cuboid.

The Cuboid.—Situated on the outside of the foot, very thick and massive as contrasted with the preceding, like it also presents for description two surfaces—a posterior and an anterior, with a circumference. Commencing with the posterior surface, it exhibits an articular facette for the os calcis, covered with cartilage, convex from above downwards, and concave from side to side; while the anterior, cut off obliquely from within, backwards and outwards, has on it two facettes, separated by a slight vertical ridge, the internal, oval from above downwards, and slightly concave, for articulation with the extremity of the fourth metatarsal bone; the external,

larger, rounder, and flatter, and cut off obliquely, so as to form an obtuse angle with the preceding, for uniting with the fifth. The upper part of its circumference, irregularly quadrilateral and rough, broad internally, constricted externally, has attached to it the dorsal ligaments for the contiguous bones, and gives origin to a slip of the extensor brevis; the external very short from before backwards, has on it the commencement of the groove for the tendon of the peronæus longus; the inferior presents anteriorly, the continuation of this groove for the peroneal tendon, directed forwards and inwards, while more posteriorly it is quadrilateral, elevated, and covered with cartilage, affording attachment to the two portions of the calcaneo-cuboid ligament, and insertion to a slip of the tibialis posticus; internally the bone becomes more expanded, its two anterior thirds being covered with cartilage, to articulate with the external cuneiform, while a facette is sometimes visible on its posterior third, where it is in contact with the scaphoid, but this is not invariably the case.

The cuboid articulates with four bones, occasionally with five, viz., the os calcis posteriorly; the fourth and fifth metatarsal bones anteriorly; and the external cuneiform and sometimes the scaphoid internally.

Internal Cuneiform.—Triangular, with the base inferiorly, and apex superiorly, presents for examination a posterior and anterior extremity, an internal and external surface, and a superior and inferior margin. Of these, the posterior extremity is marked by an ovoid facette, wider below than above, concave, and covered with cartilage, to articulate with the scaphoid, while the anterior is likewise characterised by one similar in shape, but longer, and slightly concave from above downwards, and convex from side to side, to unite with the metatarsal bone of the great toe; the internal surface, rather quadrilateral, flattened and rough, gives attachment by its margins to ligaments which connect it to the adjacent bones, and towards its anterior and inferior part to the tendon of the tibialis anticus; externally it presents two facettes, separated by a slight ridge, the posterior triangular, for uniting with the middle cuneiform, and the anterior, more oval, for the side of the metatarsal bone of the second toe; superiorly it is sharp, and convex where it enters into the formation of the arch of the foot, while inferiorly it is broad and expanded, presenting towards its anterior part a tubercle for the attachment of the tibialis posticus; a few fibres of the peronæus longus are likewise inserted into its outer edge.

The internal cuneiform articulates with four bones, viz., the scaphoid posteriorly, the first metatarsal bone anteriorly, and the middle cuneiform, and second metatarsal bone externally.

Middle Cuneiform.—Nearly of the same shape as the last, but much smaller, while its base, which is turned upwards, is nearly a perfect quadrilateral. It presents, like the preceding, a posterior and anterior extremity, an internal and external surface, with a base, and an apex. On the posterior extremity, may be observed a facette, broad above, narrow below, covered with cartilage, for articulation with the scaphoid, while on the anterior is another of the same shape, but slightly convex for the second metatarsal bone; on its internal side is a small triangular facette, for uniting with the internal, and on its outer side a similar one for the external cuneiform bones, both of these being of a triangular shape, and situated near the upper margins, while that part of the bone below them is very rough, for the attachment of ligaments. Its apex, which presents a sharp, well-defined edge, is situated inferiorly, and is concealed by the approximation of the two bones on either side, while its base, almost perfectly flat, is rough for the attachment of ligaments.

This bone also articulates with four, viz., the scaphoid behind, the second metatarsal bone in front, and the internal, and external cuneiform bones laterally.

The External Cuneiform, intermediate in size between the two last described, presents for examination precisely the same parts. On its posterior extremity, a plane, oval facette covered with cartilage is visible, for articulation with the scaphoid; and on its anterior another, triangular in shape, and slightly convex, for the third metatarsal bone; on its internal surface it has two, one posteriorly, for the middle cuneiform, and one anteriorly, for the second metatarsal bone; while on its external, two may be likewise observed—the posterior, large, flat, and triangular, for the cuboid; and an anterior, much smaller, and oval in shape, for the fourth metatarsal bone; its apex, which is turned downwards, is more rounded than that of the preceding, affording origin to one head of the flexor pollicis brevis, while its base, directed upwards and forming a part of the dorsum of the foot, is rough for the insertion of ligaments.

The external cuneiform articulates with six bones, viz., the scaphoid posteriorly; the third metatarsal anteriorly; the second metatarsal, and middle cuneiform internally; and the fourth metatarsal and cuboid externally.

All the tarsal bones just described are developed from a single point of ossification, with the exception of the os calcis, which has two, one of these being primitive for the anterior part of the bone, and the other complementary for the calx or heel.

The Metatarsal Bones are five in number, all belonging to the class of long bones, and as such being divided into two extremities

and a shaft. The posterior extremities of all are, generally speaking, thick and clubbed, and articulate with the tarsal bones, while their anterior, also expanded, are rounded, to articulate with each of the first phalanges. The shafts are constricted and prismatic in shape; concave inferiorly, and convex superiorly, with the sides flattened and opposed to each other, and giving origin to the interossei muscles. Regarding what we have stated above as the characters common to the whole, we may now proceed to examine the peculiarities which each may individually present, when we will find them to be the following:—The first is remarkable for its greater shortness and thickness; its posterior extremity being marked by a large, oval, concave facette, for uniting with the internal cuneiform bone, while externally a small articulating surface is visible on it, where it is in contact with the second metatarsal bone; superiorly and internally it affords insertion to the tibialis anticus, and inferiorly and externally is a tubercle, for the attachment of the tendon of the peronæus longus; while all the rest of the circumference is rough for the ligaments which connect it to the internal cuneiform posteriorly; its shaft is conspicuous for its extreme thickness, and its anterior extremity rounded and covered with cartilage, to articulate with the first phalanx, presents on either side two well-marked tubercles, for the attachment of the lateral ligaments which connect it to the latter bone.

The second metatarsal bone is distinguished by its greater length as contrasted with the others, a peculiarity resulting from the manner in which it is wedged in between the three cuneiform bones, and hence it presents not only a concave facette on its posterior extremity, for articulation with the middle, but likewise smaller ones on each side, where it is in contact with the first and third cuneiform bones, as well as those for the corresponding metatarsal bones. The upper part of the tarsal extremity is broad and rough, for the attachment of ligaments, while its lower is marked by a small tubercle, for the insertion of an offset of the peroneal tendon. Its shaft is thin and prismatic, and terminates in a head of the same shape, but smaller than that of the preceding.

The third metatarsal bone, shorter than the last, has one facette only posteriorly, which is triangular, but nearly flat, for articulation with the third cuneiform bone: with one on either side for the adjacent metatarsal bones, its upper surface being broader, and the lower sharper, than those of the preceding; the one giving attachment to the dorsal ligament, and the other to the plantar, as well as to some fibres of the tendon of the tibialis posticus. Its shaft and head present no marked difference from those of the preceding.

The fourth metatarsal bone is about the same length as the last, but

rather more slender, and on it we may observe two facettes posteriorly; one quadrilateral in shape, flat, but rounded below, to articulate with the cuboid, the other smaller and more oblong, to unite with the external cuneiform bone, while it also presents the small articulations, internally and externally, for the adjacent metatarsal bones. Its upper and lower parts are both rough for the attachment of ligaments, the shaft and head being similar in appearance to those of the preceding.

The fifth metatarsal bone has the following peculiarities at its posterior extremity; it is cut off obliquely from within backwards and outwards, covered with cartilage on its inner two thirds, so as to form a triangular facette for articulation with the cuboid; and its external third is prolonged backwards and outwards into a remarkable process called the spur, which affords insertion to the tendons of the peronæus brevis, and anticus. On its inner portion is a small facette, where it is in contact with the fourth metatarsal bone, while its outer is rough, for the insertion of the external slip of the plantar fascia. It is broad and irregular superiorly, for the dorsal ligaments; and presents a similar character inferiorly, where it affords an origin to the flexor brevis minimi digiti. The shaft is more prismatic in shape than those of the preceding, but in the appearance of the head little or no difference can be observed.

The Phalanges, like those of the hand, are fourteen in number, as the great toe, like the thumb, is deficient in the second. They all belong to the class of long bones, presenting two extremities which are very much expanded, and a constricted shaft which is convex superiorly, but flattened and concave inferiorly.

The two phalanges of the great toe are remarkable for their larger size as contrasted with those of the others, though they still present general characters precisely similar; but at the metacarpo-phalangeal articulation, a sesamoid bone is always found on either side, the internal affording insertion to the inner head of the flexor pollicis brevis, and abductor pollicis; the external to the adductor pollicis, the transversalis pedis, outer head of the flexor pollicis brevis, and slip from the peronæus longus; while into the base of the second phalanx inferiorly is inserted the flexor pollicis longus, and superiorly the extensor. The corresponding rows of the four outer toes, present so striking a resemblance to those just described that they can only be distinguished from each other by their size, as they imperceptibly become smaller from the second to the fifth; they are all excavated posteriorly, forming cups for the reception of the heads of the adjacent bones, while anteriorly they are rounded and convex, and divided on their under surface into two small condyles, which are accurately adapted to similar facettes

on the contiguous phalanges. The appearance of the last is remarkable for the very peculiar constriction in its centre, for the well-marked expansion at its distal extremity, and the want of an articulating facette. Both at their distal and proximal ends, laterally, are the tubercles, for the attachment of the lateral ligaments; while superiorly they are invested for their entire extent by the aponeurosis derived from the long extensor tendons, while inferiorly they form the anterior part of the sheath in which the flexor tendons work; the base of the first giving insertion to the lumbricales and interossei; the middle of the second to the flexor brevis; and the base of the third to the flexor longus.

The bones of both the metatarsus and phalanges are developed from two points of ossification—one for the shafts, and one for the posterior extremities. They are visible at varying periods before birth, but are not completely united till the eighteenth or twentieth year.

The foot, the great point of support of the entire body, is remarkable for its extreme strength, as well as for an extent of elasticity which imparts a facility of motion and springiness in progression, which man possesses in a very eminent degree. Regarded as a whole it is of a triangular shape, with the apex behind and the base in front; but because three points only meet the ground when resting upon it, it has been compared to a tripod; the posterior leg being represented by the os calcis; and the two anterior, externally by the base of the little toe, and internally by that of the great. Between these points, three remarkable arches are formed; that on the inside being much the longest, strongest, and, owing to its curvature, enjoying a large amount of elasticity; accordingly we find that it is upon it the principal weight of the body is thrown when in progression, the deep excavation which here naturally exists in almost all individuals being commonly known as the hollow of the foot. The external arch wants the concavity so obviously to be observed in the last, and is much shorter, in many instances presenting almost a plane surface—the term flat-footed being applied to cases of this description. The transverse arch extends between the balls of the great and little toe, and is the shortest of the three, but it is extremely elastic and moveable, readily adapting itself to the inequalities which it may meet with, and again resuming its original shape where these cease to exist. It can readily be imagined what a tendency these arches must possess for breaking the shocks to which we are constantly so liable, but of which at the movement our minds are rarely sensible, unless at some unconscious moment, when the foot, unprepared for such an occurrence, may slip suddenly from an elevation into a depression; here the shock, striking on the os calcis

only, and not on the arches, is propagated upwards along the limb, losing, no doubt, much of its intensity at each joint and angle of curvature, but still being severe enough to cause some unpleasant feelings in the highest part of the framework of the human skeleton, and quite sufficient to make us aware of that provident care and foresight that has been exercised in this portion of it, to preserve us from the more frequent repetitions of such unpleasing incidents.

Directing now our attention to the dorsum of the foot, we observe that it is likewise arched, with the convexity looking upwards, but varying in its intensity essentially in different individuals, in some being considerable, in others presenting little or no elevation, but being always higher on the inside than on the outside of the foot. It is interrupted some distance behind its centre, by its articulation with the bones of the leg; and prolonged behind into that peculiar process called the calx, forming the arm of the lever, to which the powerful muscles of the calf being attached, are thus enabled to raise the body on the anterior part of the foot, thus bringing into play the elasticity of the phalangeal arch, an arrangement hitherto but little noticed, or at least not so amply considered as its essential service in progression would seem to demand. The buttresses of this arch are, on the one side, the distal extremities of the metatarsal bones; and on the other, the points of the toes themselves. Now, the latter being always in a state of semi-flexion, which would appear to be their natural condition, but becoming forcibly extended when the superincumbent weight is applied to them, as promptly endeavour to recover their original position when this weight is removed, and hence arises that springy impetus forwards, which even in walking, every one must have experienced for himself, but which never can be enjoyed by one who has lost the phalangeal extremities either by accident or disease.

THE SKULL.

We will now proceed to examine one of the most important parts of the whole skeleton—the cranium; but, before doing so, will merely state here that it is situated on the upper part of the spinal column; that it is of an irregular, ovoid shape, broader behind than in front, and that it becomes blended with the bones of the face, which lie anterior and inferior to it, reserving the more general observations on it as a whole, till we have examined minutely the several separate bones of which it consists.

The Cranium is formed of eight bones, four of which are single, viz., the frontal, occipital, sphenoid, and ethmoid; and two double.

viz., the parietal and temporal,—one being found on either side. All these boues, as a rule, beloug to the class of flat bones, haviug as such an iuterual and external plate, with an intervening diploe, or cellular layer. Of these, the external is remarkable for its tenacity of fibre aud great elasticity, in this respect contrasting strikingly with the iuternal, to which, owing to its fragility and brittle nature, the term *vitreous* has been applied; and this not without just grounds, as it is now a well ascertained fact that the latter may be shivered or starred from the effects of a blow, that may have caused not the slightest perceptible injury to the former. The diploe, which separates the two plates, is extremely cellular in its nature, and is traversed by numerous large venous vessels which may be injected aud demonstrated by simply raspiug away the external plate—the parietal bone, being always selected as the oue best adapted for showiug the peculiarities here alluded to. With those brief remarks we will proceed to the description of the froutal bone.

FRONTAL.—Has been compared in shape to a bivalve shell, being smooth and ~~concave~~ convex externally; but coucave interually, the latter surface being marked by prominences and pits corresponding to the convolutions of the brain, kuown by the name of mamillary elevations aud digital depressions. It lies the most anterior and superior of all the other boues, forming part of the cranium, forehead, and orbits, and in examining it we will give it two surfaces—an external and internal, with a circumference. Of these, the external surface may be divided into two parts; the cranial reaching from its margin posteriorly, where it articulates with the parietal to the supra-orbital ridges; and the orbital extendiug backwards from the last-named point to its posterior thin edge, where it articulates with the lower wing of the sphenoid. Directing our attention first to the cranial portiou, we find it to be convex, very smooth, aud covered in its whole extent by the occipito-frontalis muscle; it preseuts in its mesial line an irregular ridge, indicating the juuction of the two parts which composed it in fœtal life, and terminating below in a sharp pointed process called the spine; on each side of this ridge, rather auteriorly, is an elevation, corresponding to the poiuts of ossification of the bone which are called the frontal eminences; while below this it is smoother where it is covered by the eyebrow; still lower are the superciliary arches, prominent at the extremities, but rounded in the centre, forming about one-third of a circle, aud presenting a notch, sometimes a complete foramen, at the junction of their middle with the internal third, for the passage of the supra-orbital artery, and supra-orbital nerve; a small hole leads from this notch iuto the diploe of the bone, conveying a miuute nerve aud vessel, for the supply of the sinuses. The superciliary arches are bounded exterually aud

internally by what are termed the angular processes; the external being deeply serrated to articulate with the superior orbital process of the malar bone, a curved ridge being continued backwards and outwards from this point, and circumscribing that small portion of the bone, semi-lunar in shape, which enters into the formation of the temporal fossa, and gives origin to the muscle and fascia of the same name; the internal angular process, situated on a plane anterior to the preceding, is also very rough, and articulates above and in front with the nasal bones, and a little farther back with the nasal process of the superior maxillary; to these on each side are attached the orbicularis palpebrarum and corrugator supercilii. Separating the two internal angular processes, a prominence appears in the mesial line called the spine; this is of variable length in different individuals, and is slightly curved downwards and forwards, giving support to the small nasal bones already alluded to. On either side of the spine, but a little above it, are the frontal sinuses, small, and occupying a position between the internal and external plates of which the bone is composed, well marked in the adult and aged, but not visible in fœtal life. If we now turn to the orbital portion of the bone, we will find that it curves backwards and downwards, forming nearly a right angle with the cranial. It consists of two distinct plates, triangular in shape, with the base anteriorly formed by the superciliary arches, and apex posteriorly and internally; they are concave and smooth, forming the upper wall of the orbit, looking downwards and forwards, and presenting a deep depression externally and anteriorly, for the lachrymal gland, while a small spiculum of bone, sometimes merely cartilage for the pulley of the superior oblique, is situated near its internal and anterior part. The orbital processes are extremely thin, and separated from each other by an oblong interval, which is filled up in its natural condition by the cribriform plate of the ethmoid, and hence called the ethmoidal notch; the sides of this notch are cellular anteriorly, where they communicate with the frontal sinuses; but rough posteriorly, where they present slight rounded depressions, which are converted into foramina by their junction with the ossa plana of the ethmoid, known as the anterior and posterior orbital foramina; the former transmitting the anterior ethmoidal artery, and nasal twig of the ophthalmic, and the latter the posterior ethmoidal artery only. The posterior margin of the orbital plate is beveled off on its upper surface internally to support the lesser wing of the sphenoid; but on its under surface externally, to rest upon its greater wing. The remainder of the circumference of the frontal bone is thick and serrated, and articulates for its whole extent with the parietal bones, but in such a manner that while it overlaps them superiorly, it is in turn over-

lapped by them inferiorly, constituting what is termed the coronal suture.

Turning now to the internal surface of the bone, it will be found deeply concave and uneven, owing to the depressions and elevations already alluded to. At its most anterior part, and in the mesial line, we observe a hole, but sometimes imperfect, under the latter circumstances being completed by the ethmoid; this is the foramen cœcum, forming a communication between the nose and the great longitudinal sinus. Passing upwards and backwards from this point a ridge is observed which, after proceeding for a short distance, bifurcates, leaving a groove for the attachment of the falx cerebri, depressions for the glandulæ Pacchioni being frequently seen on either side of it. The upper part of the orbital plates, exceedingly convex and irregular, form the principal portion of the anterior fossæ of the cranial cavity for the support of the anterior lobes of the brain.

The frontal articulates with four bones of the head, viz., the two parietal, sphenoid, and ethmoid; and with eight of the face, viz., the two nasal, two superior maxillary, two lachrymal, and two malar. It has thirteen processes, viz., two orbital, two superciliary arches, four angular, two frontal eminences, two temporal ridges, and one spine. Its proper foramina are three in number, viz., two supra-orbital, and one foramen cœcum, while its common are six, viz., four ethmoidal or orbital, and the openings of the two frontal sinuses. It is developed from two points of ossification, one for each lateral portion, the ossific nucleus being visible about the sixth week, in the orbital arches; and at birth, while their lower parts are in contact, their upper are still unconnected with each other, having between them an interval constituting one-half of a space known as the anterior fontanelle. During the first year they are united by a suture called the naso-frontal, which generally becomes gradually obliterated, especially towards its posterior part, although it may continue to persist to a very advanced age. In early life, the frontal sinuses are not developed; but they make their appearance towards the termination of the first year after birth, and continue to increase gradually in size until death puts a period to their further progress.

The Parietal Bone, situated on the lateral and superior part of the cranium, is of a quadrilateral shape, presenting two surfaces, an external and internal; and four margins, an anterior, posterior, superior, and inferior. Of these, the external surface very convex and smooth, is covered on its upper part by the tendon of the occipito-frontalis; while towards its posterior-superior angle a small foramen is frequently observed, giving passage to one of the emissary veins of Santorini, by this means establishing a communication between

the vessels externally and the great longitudinal sinus; a little below its centre a well-marked prominence is seen, where the primary ossific nucleus called the parietal eminence is laid down; and still lower a curved ridge, forming the upper boundary of the temporal fossa, and affording attachment to the temporal muscle and fascia, while its inferior margin is beveled off obliquely to allow it to be overlapped by the squamous plate of the temporal bone, constituting the squamous suture. The internal surface of the bone is concave, uneven, and marked like the frontal with mammary eminences and digital depressions, while it is likewise traversed by several grooves for the middle meningeal artery; one of these, better marked than the others, appearing in front for the main trunk; this last-named groove, of great importance to the surgeon, varies in the appearance which it may present, being sometimes quite superficial, at others exceedingly deep, and sometimes a complete bony canal, in which the vessel may lie concealed, but the position which it occupies is almost always the same, being invariably found about half an inch from the anterior edge; another groove, much broader and deeper, but very limited in length, is seen at its posterior-inferior angle, where it corresponds to the lateral sinus. Of its four borders, the superior is the longest and straightest; it is deeply serrated, and marked by prominent spicula, similar in shape to the pointed head of an arrow, which interlock with their fellows of opposite sides, forming the sagittal suture. From this the anterior border bends downwards at nearly a right angle, being slightly concave, and cut off superiorly, so as to be overlapped by the frontal, but beveled off inferiorly, so as to rest upon the same bone, forming the coronal suture. The inferior margin presents a double curve, both concave downwards, the anterior, the longer of the two, being beveled off on its outer surface to articulate with the squamous plate of the temporal forming the squamous suture, while the posterior, very thick and rough, unites with its mastoid portion. The posterior margin of the bone is irregularly spiculated, convex, and generally marked by deep undulations; these latter being filled up by separate pieces of bone, known as ossa Wormiana or triquetra; it articulates with the occipital bone, forming the lambdoid suture. Of its four angles, the anterior superior is always known by its close approach to a right angle—its posterior superior by the emissary hole of Santorini, when it does exist—the posterior inferior by the sulcus for the lateral sinus, and the anterior inferior by its greater elongation and the groove for the middle meningeal artery. It may be necessary to state, that the internal surface, near its upper part, is often marked by depressions of variable size and depth, the result of absorption caused by the pressure of the Pacchionian glands.

The parietal articulates with five bones, viz., the frontal, sphenoid, temporal, occipital, and its fellow of the opposite side. It has but a single process, the parietal eminence; and one proper hole, which is sometimes absent, that for the emissary vein of Santorini, while it is developed from a single point of ossification, which is visible between the fifth and sixth week. In fœtal life it is not quadrilateral, but oval in shape, its angles at this period not being developed, and hence the existence of the fontanelles, which are six in number, viz., one anterior and superior, of a diamond figure, formed by the two parietal and the frontal, the latter at that time consisting of two distinct bones; a posterior superior, triangular in shape, its sides formed by the parietals, its base by the occipital; an anterolateral, very small and semilunar, bounded by the parietal, frontal, and sphenoid; and a postero-lateral, oval in figure, constituted by the occipital, temporal, and parietal.

The Occipital Bone.—Is of an irregular oval shape, pointed anteriorly and posteriorly, and occupying when in position the posterior and inferior portion of the cranium. In examining it, we must divide it into an anterior and posterior surface, with a circumference. Of these the posterior surface is convex and smooth in its upper third, where it is covered only by the integuments and cellular tissue, which is here particularly dense, and in which ramify the terminal branches of the occipital artery and great occipital nerve; a little lower down, and in the mesial line, is a prominence of variable size, called the occipital protuberance, giving attachment to the ligamentum nuchæ; and on either side of this are two well-marked ridges, extending out as far as the mastoid portion of the temporal bone, affording origin by its two external thirds superiorly to the occipito-frontalis; and inferiorly, for the same space, having inserted into it the sterno-cleido-mastoid, while the trapezius arises from its internal third. Below this is a groove into which two muscles are inserted,—the complexus internally, and the splenius capitis externally; and still lower is another ridge, but not so well marked as the preceding, for the attachment of the rectus capitis posticus major, and superior oblique; while between this and the foramen magnum is a slight depression, for the insertion of the recti minores. Running vertically downwards from the occipital protuberance, and separating the bone into two parts, a slight, elevated crest may be observed; this, the analogue of the vertebral spine, on reaching the foramen magnum, bifurcates into two processes, that surround its edges, and meet again in front at the basilar process. The hole thus formed is one of great importance; it is oval in shape, with its long measurement from before backwards, and apparently larger on its superior than its inferior aspect; it gives passage to

the medulla oblongata and its membranes, to the vertebral and spinal arteries, and to the spinal accessory nerve. As we pass along the margins of this foramen, we meet, inferiorly and laterally, with the condyles, situated anterior to the transverse axis of the hole, and of an oval shape, converging anteriorly, covered with cartilage, and looking downwards, forwards, and outwards, to articulate with the oblique processes of the atlas; on their inner side is a small depression, for the insertion of the check ~~cheek~~ or moderator ligaments, while externally they become continuous, with a process somewhat elevated, and extending directly outwards,—the jugular or transverse, which gives attachment to the rectus capitis lateralis, and forms the posterior boundary of the jugular or posterior lacerated foramen. Passing immediately through the root of the condyle are two foramina—one in front, large, and directed forwards and outwards—the anterior condyloid, through which is transmitted the lingual or ninth nerve, with the small occipito-meningeal artery; the other much smaller, directed backwards and outwards, sometimes altogether absent,—the posterior condyloid, for the passage of a small vein, to establish a communication between the lateral sinus internally and the vertebral vein externally. The basilar process, which lies in front of the foramen magnum, is thick and quadrilateral in shape; convex and rough on its inferior surface, where it gives attachment to the following parts from behind forwards:—Most posteriorly, and to the lip of the opening, the apparatus ligamentosus colli; secondly, to the broad and cord-like portions of the occipito-atloid ligament; thirdly, to the rectus capitus anticus minor; fourthly, to the rectus major; fifthly, to the middle, and, sixthly, to the superior constrictors of the pharynx; and lastly, towards its anterior part, it is covered by the mucous membrane of the pharynx. The sides of the basilar process are excavated posteriorly to assist in forming the posterior lacerated hole, and rough anteriorly, to articulate with the edge of the petrous portion of the temporal bone, while in front it is irregular, to unite with the posterior part of the body of the sphenoid, from which it is always most difficult to detach it, the union of the two bones constituting what has been called the clivus basis cranii; on its superior aspect it is concave from side to side, sloping downwards and backwards to the foramen magnum, where it supports the medulla oblongata, sixth pair of nerves, and basilar artery. As we proceed backwards from this point, we again meet with the foramen magnum, on the edges of which, corresponding to the condyles inferiorly, an oblong, elevated process of bone, formed by the upper wall of the anterior condyloid hole, may be observed, while behind and external to it, is a short but deep groove for the lateral sinus, immediately before it empties

itself into the internal jugular vein. The anterior surface of the bone is concave in its entire extent, but divided into four compartments by two lines, which intersect each other at a right angle about the centre, forming at the point of intersection an elevation which corresponds to the torcular Herophili internally, and to the occipital protuberance externally. Of the chambers thus mapped out the two superior are triangular in shape, and contain the posterior lobes of the cerebrum, while the two inferior are irregularly quadrilateral, to support the hemispheres of the cerebellum. The vertical ridge which divides them stretches from the foramen magnum below to the highest part of the circumference above, where it becomes continuous with the sagittal suture, being prominent and well marked inferiorly, where it gives attachment to the falx cerebelli, but much more depressed superiorly, where the falx cerebri is connected to it. The transverse ridge is double, with a groove corresponding to the great lateral sinuses occupying its centre, while to its lip above and below is attached the tentorium cerebelli. If we now direct our attention to the circumference of the bone, we will find it to be deeply serrated above, for articulation with the parietal, several deep indentations occasionally occurring for the reception of the ossa triquetra; here it is also comparatively thin; but below, where it unites with the temporal, it becomes thicker and less spiculated, while anterior to the short groove for the termination of the lateral sinus, the margin becomes smooth and concave, where it joins with the temporal to form the foramen lacerum posterius; a slight spiculum of bone frequently springing from its margin, and dividing it into two parts, the smaller portion being situate anteriorly.

The occipital articulates with six bones, viz., the two parietal, two temporal, sphenoid, and atlas. Its processes are six in number,—the two condyles, two jugular eminences, the basilar and occipital protuberance. It has five proper foramina,—the foramen magnum, the two anterior and the two posterior condyloid; and two common,—the anterior and posterior lacerated holes, the one being formed by three bones, viz., the body of the sphenoid, basilar process of occipital, and point of the petrous portion of the temporal, the aperture, in its natural condition, being filled up with cartilage, and traversed by the Vidian nerve in its passage into the cranial cavity; while the other is circumscribed by two bones only,—the occipital and temporal, and gives passage to the jugular vein, the spinal accessory pneumogastric, and glosso-pharyngeal nerves.

The occipital bone is developed from four osseous points,—one for the basilar process, one for either condyle, and one for the upper part; the first ossific point being visible from the seventh to the eighth week.

The Temporal Bone.—Of an irregular oval figure, and placed in the lateral and inferior part of the cranium, has been divided by anatomists into three portions, viz., a squamous, situate anteriorly and superiorly; a mastoid, posteriorly and inferiorly; and a petrous internally, at the junction of the other two. Commencing with the description of the squamous, we will find it to be of a semilunar shape, limited inferiorly on its internal surface by the petrous portion; and on its external, in the same direction, by the zygomatic arch; while in its curved outline superiorly it is bounded by the free margin of the bone. Its outer surface, very smooth and convex, enters into the formation of the temporal fossa, of which it forms a large part, and gives origin to the muscle of the same name; while its inner is marked more strikingly by mammillary eminences and digital depressions than are found in any of the other bones already described; its lower edge exhibits a narrow, wavy groove, extending in a direction backwards and outwards, indicating the original division between it and the petrous portion; while its margin, particularly superiorly, is beveled off so as to overlap the parietal bone, constituting the squamous suture. The zygomatic arch is a process of bone, a little more than an inch in length, cut off obliquely on its under surface anteriorly, and serrated so as to rest on the malar, from which it stretches backwards to a tubercle on its under surface, where it bifurcates into its two roots; its upper edge thin and sharp, gives attachment to the temporal fascia, and its lower thicker, to the parotidean aponeurosis; its internal surface is concave and smooth, to allow the temporal muscle to glide behind it to its insertion; while its external, likewise smooth but convex, gives origin to the deep portion of the masseter and zygomaticus major. The tubercle, to which we have alluded, which limits it posteriorly, is situated on its inferior aspect, and from it the external lateral ligament of the lower jaw arises; at this point the zygomatic arch bifurcates into its two roots, the horizontal and transverse,—the one extending backwards towards the mastoid portion, where it becomes gradually lost; the other bending inwards and slightly backwards, though at first elevated and rounded, is as imperceptibly lost towards the inner margin of the bone. The glenoid cavity, an oval depression, long from before backwards and inwards, lies in the angle of bifurcation, and is itself divided by the Glaserian fissure, which runs from without forwards and inwards, into two parts, the anterior, the larger and more concave, for the condyle of the lower jaw; and the posterior, smaller and flatter, lodging the glenoidal process of the parotidean gland. The Glaserian fissure is remarkable for affording attachment to the capsular ligament; and it is also said to give passage to the Vidian nerve, and laxator tympani muscle, but

improperly, as we have always observed the former to emerge internal to it, and the latter ought to be considered, not as a muscle, but rather as a band of fibrous tissue, stretching from the spinous process of the sphenoid to the point of the processus gracilis of the malleus, which descends downwards within the lips of the fissure to meet it. Immediately behind the glenoid cavity are two processes known as the styloid, and vaginal; the first or styloid, as its name implies, is similar in figure to the ancient pen, being broad at its base where it is in connexion with the vaginal, but thin and pointed inferiorly, and of very variable length; it is directed forwards and downwards, gives attachment by its apex to the stylo-glossus; by its middle to the stylo-hyoid; and by its base to the stylo-pharyngeus; two ligaments are also connected to it, the stylo-maxillary above, and the stylo-hyoid below. The vaginal process, which surrounds the base of the styloid like a sheath, is a sharp elevated ridge of bone, which can be traced forwards and inwards to form the outer wall of the carotid hole, an important relation in the surgical operation of dividing the capsule in the removal of the lower jaw, while posteriorly it stretches back as far as the mastoid process, from which it is separated by a slight groove, through which the auricular branch of the facial nerve glides to supply the retrahens muscle of the ear; anteriorly and externally it passes upwards and forwards to separate the glenoid cavity from the external auditory meatus (processus auditorius), and terminates at the outer edge of the fissure of Glaser, by bending backwards on a plane posterior to a small offset from the horizontal root of the zygoma, which descends directly in front of it. The external auditory meatus, which lies superior and posterior to the last described cavity, is of an oval shape, long from above downwards, with its edges rounded off except anteriorly, where it is sharp and rough, this being the terminal portion of the vaginal process already described, but more generally known as the auditory; behind it is the mastoid process, and above it the horizontal ramus of the zygoma; while to its edges is attached the cartilage, which completes the tube of the ear, and which, with the bony portion to be more particularly described hereafter, forms a canal about an inch in length.

The mastoid portion of the bone, much stronger and thicker than the squamous, is triangular, or nipple-shaped in figure, and hence its name; its margins, broad and serrated, articulate above with the posterior-inferior angle of the parietal, and behind and inferiorly with the occipital; its external surface is rough and convex, expanded superiorly, but gradually becoming more contracted as it descends, until at length it terminates in a mamillary tubercle, termed the mastoid process; its whole expanse from above down-

wards affording attachment to the following series of muscles, viz., most superiorly to the occipito-frontalis, a little lower to the sterno-cleido-mastoid; lower still to the splenius capitis, and anterior to these, to the retrahens aurem; while above, and towards its superior edge, is a small hole for the emissary vessel of Santorini, establishing a communication between the occipital vein and the lateral sinus. On the inferior part, and directly internal to the mastoid process, is a deep furrow called the digastric fossa, for the origin of the muscle of the same name; and internal to it is a much shallower groove for the occipital artery, the two depressions being separated from each other by a crest of bone, triangular in shape, and slightly elevated for the insertion of the trachelo-mastoideus. If we now turn to the internal surface, we will find it to be limited in front by the base of the petrous portion, which likewise forms the anterior boundary of a deep groove, corresponding to the lateral sinus; and behind this is a small oval portion, uneven, long from above downwards, forming the external boundary of the fossa, for the reception of the lobes of the cerebellum.

The petrous portion of the bone, so termed from its stony hardness, is prismatic in shape; with its base, which is cut off very obliquely, and turned backwards and outwards, corresponding to the union of the squamous and mastoid portions, and its apex, turned forwards and inwards, truncated and rough internally, but pierced externally for the termination of the carotid canal, wedged in between the posterior part of the great wing of the sphenoid and the basilar process of the occipital, forming the posterior boundary of the anterior lacerated foramen, already described with the latter bone. In examining it, we will give it three surfaces; a superior, an internal, and an inferior, separated from each other by as many margins, which may be described as the superior internal, inferior internal, and superior external. The superior surface is separated from the squamous portion, externally by the slight wavy fissure already alluded to, but not posteriorly, as there it becomes completely blended with it, and is marked with alternating elevations and depressions, more especially posteriorly and externally, where we observe an elevation conspicuous by its size; this corresponds to the superior semicircular canal, a part which will be more accurately described in examining the internal ear; while about three-quarters of an inch anterior to it is a small groove, directed backwards, and terminating in a foramen, called the hiatus Fallopii, leading into the aquæductus Fallopii; through this small hole, is transmitted the Vidian nerve, from Meckel's ganglion and the Vidian branch of the middle meningeal artery. Slightly external, and anterior to the hiatus, is another foramen, much more minute in its character, for

the passage of the nervus petrosus superficialis minor, a branch of the tympanic division of Jacobson, while anterior to these apertures is a slight ridge, corresponding to the upper part of the cochlea; and still more anteriorly, near the point of the bone, a depression on which rests the Casserian ganglion of the portio mollis of the fifth pair of nerves. Its superior internal edge, grooved slightly for the superior petro-salsinus, which communicates posteriorly with the great lateral, and anteriorly with the cavernous, exhibits immediately behind its apex a small concave notch, which is changed into a semilunar foramen by the sinus, which crosses it; through this pass the two portions of the fifth nerve, to reach the depression already alluded to. The internal surface of the bone forms the external boundary of the posterior fossa of the cranium; it is convex and irregular, presenting a large opening at the junction of its middle with its anterior third, oval in shape, directed obliquely backwards and outwards, known as the internal auditory meatus. As we look into the bottom of this cavity, we observe, superiorly and anteriorly, a large foramen, which opens into the aqueduct of Fallopius, through which passes the portio dura nerve, while in the inferior part of it may be seen several smaller foramina, known as the lamina spiralis foraminulenta, being in fact the base of the cochlea, through which the branches of the portio mollis pass into the vestibule. Behind, and a little superior to the meatus, is a slight fissure, likewise directed backwards, called the aqueduct of the vestibule, for the transmission of a small vein from that cavity to the superior petrosal sinus; while below and behind it is another cleft, not, however, always present, into which the dura mater insinuates itself. The inferior internal margin, very irregular in its outline, commences posteriorly in a slight depression, corresponding to the inner wall of the jugular fossa, and then a small elevation follows, separating the last from a slight notch, which is the internal boundary of the aqueduct of the cochlea, while in the remainder of its course it is convex and rough, to articulate with the basilar process of the occipital bone. The inferior surface forms part of the base of the cranium, and is by far the most irregular of the three. Anteriorly, it is exceedingly rough, and gives attachment to the petro-pharyngeal aponeurosis, and levator palati; while more posteriorly, but externally, is a large foramen, the carotid, into which enters the artery of that name, with branches of the superior cervical ganglion of the sympathetic, known as the nervi molles. A thin crest of bone separates the carotid hole from a depression of variable depth, immediately behind it, called the jugular fossa; and in this crest, a minute foramen may be observed, for the tympanic branch of Jacobson in its course to the tympanum; while in the outer wall of the jugular fossa is ano-

ther equally small, for the passage of Arnold's auricular twig, to reach the stylo mastoid-hole. Directly behind the jugular fossa, and internal to the carotid hole, is a small cleft of a triangular shape, termed the aqueduct of the cochlea, for the transmission of a small vein to the inferior petrosal sinus; while at the most posterior part of the inferior surface, just as the digastric groove commences, and between the styloid and mastoid processes, but internal to both, is another hole, the stylo-mastoid, through which emerges the portio dura nerve, and into which enters a small branch of an artery from the posterior auris to anastomose in the aqueduct of Fallopius, with the Vidian branch of the middle meningeal. The external superior, the shortest of the three margins, forms a very acute angle with the squamous portion, and at the point of junction we observe a canal leading backwards and outwards, and divided into two by a thin plate of bone, called the processus cochleariformis; the superior, the smaller, giving origin to the tensor tympani; and the inferior, larger, constituting the bony portion of the Eustachian tube. Anterior to these canals the margin becomes rough and rather broad, for articulating with the side of the spine of the sphenoid bone.

The temporal articulates with three bones of the head, viz., the parietal, occipital, and sphenoid; and with two of the face—the malar, and inferior maxillary. Its processes are six in number, viz., the mastoid, styloid, vaginal, auditory, zygomatic, and cochleariform; while it has fourteen proper foramina, viz., the external, and internal auditory, the mastoid, and stylo-mastoid, the aqueducts of the cochlea, and vestibule, the hiatus Fallopii, and the hole for the lesser petrosal nerve, the foramina for the Eustachian tube, and tensor tympani, glenoidal fissure, and carotid hole, the small openings for the tympanic nerve of Jacobson, and auricular of Arnold. The common are two—the anterior, and posterior lacerated, already described with the occipital bone.

The temporal is developed from five points of ossification: one for the squamous portion, one for the petrous, one for the mastoid, one for the auditory meatus, and one for the styloid process. These make their appearance in periods varying from the second to the fifth month, but do not become thoroughly united—we allude to the three principal portions—till a year after birth. The styloid process may remain separate for several years, and is frequently found even in the very aged, attached to the rest of the bone by ligament only. The appearance of the temporal bone in the fœtus is peculiar: the bony portion of the auditory meatus not being developed as we find it in the adult, but consisting of a mere bony ring; while the transverse root of the zygoma is but slightly elevated, so that the glenoid cavity is nearly flat. The mastoid portion of the bone is

also extremely small, and its cells, on making a section, are not as yet visible. The upper surface of the petrous portion is also remarkable for the prominence of the superior semicircular canal and size of the cochlea; while the small ossicula of the tympanum exhibit all their elements in a state of high perfection.

With respect to the remark so often quoted, of the styloid process articulating with the os hyoides, we have only to observe that, in a large number of subjects that came under our own inspection, it occurred but in one individual instance; in this case the styloid process, thick and strong, not tapering, but increasing in size towards its inferior extremity, terminated in a rounded head, which articulated with a cuplike cavity on the upper surface of the os hyoides, immediately at the junction of its cornu with its body.

The SPHENOID, is so named from the manner in which it is wedged in at the base of the cranium, forming the bond of union between all the bones of the head, and several of the face. In figure it has been compared to a bat, with the wings expanded; the similarity being still more obvious when observed with the ethmoid attached to it anteriorly. In its description we will give it a body, which we will first examine, and afterwards direct our attention to the processes which are connected to it. The central thick portion of the bone is that part of it to which the name of body has been applied; it is of a cuboid shape, presenting an upper and lower surface; an anterior, and posterior extremity, and two sides. The superior surface is very irregular, presenting in the mesial line anteriorly a slight elevation, which is prolonged into a triangular spine that fits into a corresponding notch in the ethmoid bone, while on either side of it is a slight depression, on which the olfactory nerve rests in its course forwards and inwards to the cribriform plate; and again, external to this last is the small pedicle constituting the anterior root of the lesser wing. As we proceed farther backwards from this point we reach a grooved portion of the bone, narrow and concave from before backwards, but longer and slightly convex from side to side, the olivary process, which supports the optic commisure, and which terminates at either extremity in a rounded hole, the optic, through which pass the nerve of the same name, and the ophthalmic artery; behind the olivary process is a deep excavation, concave from before backwards, called the sella turcica, which contains the pituitary gland, and a remarkable sinus, the circular of Ridley, as well as the transverse sphenoidal; more posteriorly, there is an abrupt but narrow elevation, at the extremities of which are two rounded processes, known as the posterior clinoid, which give attachment to the convex margin of the tentorium. The back part of the body is flat, but very rough, for articulation with the basilar process of the occipital; while the

inferior surface presents in the mesial line a prominent plate of bone, triangular in shape, called the rostrum or azygos process, for uniting with the vomer, the upper edge of which is split to receive it posteriorly, and with the nasal lamella of the ethmoid more anteriorly; the tongue-like prolongation of the triangular fibro-cartilage of the nose is also attached to it, while on either side of it is a deep furrow, partially overlapped by a thin lamella of bone, under which the edges of the vomer are implanted. The anterior extremity of the body has springing from it, the ethmoid spine already alluded to, descending from which is a thin crest of bone, becoming continuous with the rostrum below, and forming the septum between two cavities on either side, called the sphenoidal sinuses; these extend into the body, and occasionally into the lesser wings, and consist of several minute compartments, separated from each other by thin laminæ; the lower wall of these cavities is completed by two small curved osseous slips which connect it to the palate, known as the turbinated bones of Bertin; while external to them the bone is rough to articulate with the orbital process of the palate bone. If we now direct our attention to the sides of the body we will find that the lesser wings, or wings of Ingrassias, spring from them anteriorly and superiorly; below them the bone is smooth and concave from above downwards, where it forms part of the inner wall of the orbit, and the internal boundary or base of the lacerated orbital foramen; proceeding still further backwards it continues to preserve its smooth character, but is grooved where it forms the internal wall of the cavernous sinus; more posteriorly, it is marked by a shallow depression for the passage of the internal carotid artery, while inferiorly the greater wing springs from it by a broad, thick root. Turning now to the examination of those wings, we observe that the lesser is of a triangular shape, with the apex directed forwards and outwards, and the base inwards and slightly backwards; the latter being connected to the body by two roots, one anterior and superior, broad and strong, the other inferior and posterior, much thinner and weaker, the two separated from each other by a round foramen, called the optic foramen; the base terminates internally and posteriorly in a tuberculated process, known as the ~~posterior~~ clinoid, which gives attachment to the concave margin of the tentorium; the apex extending outwards becomes continuous with the greater wing or occasionally articulates with part of the frontal; the upper surface of the lesser wing is slightly concave, forming part of the anterior fossa of the cranium, while the inferior is partially convex, constituting the superior wall of the foramen lacerum orbitale; the posterior edge is rounded and smooth, and has connected to it the sphenoidal

fold of the dura mater; while the anterior is rough and beveled off so as to rest on the orbital plate of the frontal.

The greater wing is of an irregular wedge-like shape, and accordingly presents three surfaces, termed the superior or cerebral, the external or temporo-zygomatic, and the internal or orbital; each circumscribed by corresponding margins of articulation. Of these the superior or cerebral, irregularly rhomboidal in its outline and deeply concave for the reception of the middle lobe of the brain, exhibits in its posterior external angle a small hole, called the spinous, for the passage of the middle meningeal artery, and more anteriorly and internally another, much larger, and oval in shape, for the transmission of the hard and soft portions of the inferior maxillary nerve, and occasionally for the anterior meningeal artery, and small petrosal nerve; still, more anteriorly and internally is the foramen rotundum, much smaller and rounder than the last, and directed forwards and slightly outwards, so as to open into the pterygo-maxillary fossa for the passage of the superior maxillary nerve. The greater wing is circumscribed by four margins, a posterior, external, anterior, and internal; of these the posterior is the shortest, flattest, and broadest, being elevated into a thin crest above, forming a posterior boundary for the foramen ovale, and lying in contact with the outer side of the petrous portion of the temporal bone; the external, the longest, and at the same time concave, is thick, rough and serrated posteriorly, where it articulates with the edge of the glenoid cavity, and more anteriorly with the squamous plate, while still farther forward it is beveled off where it is overlapped by the parietal bone; the anterior edge unites with the last described at a very acute angle, and is broad and extremely rough for articulation with the frontal, while its internal is free, thin, and irregular, where it forms the inferior boundary of the lacerated hole. The external or temporo-zygomatic surface remarkable for its curved appearance; is long and convex from above downwards and inwards, but narrow and concave from before backwards; it is divided a little below the centre, by a horizontal elevated crest, into two portions, a superior or temporal, and an inferior or zygomatic; the superior is wedged in between the temporal and parietal behind, and the malar and frontal in front, where it forms part of the temporal fossa, and is bounded below by the crest already alluded to, which gives attachment to the temporal, and outer head of the external pterygoid muscle; the inferior or zygomatic, more concave and quadrilateral in shape, is limited in front by a ridge of bone, prolonged from the root of the external pterygoid plate, and above by the crest; while posteriorly and externally it presents a sharp-pointed angle, which is fitted into the interval be-

tween the squamous and petrous portions of the temporal bone; it forms the roof of the zygomatic fossa, and is perforated by two foramina, the oval anteriorly and the spinous posteriorly, while in front of, and behind the last mentioned are two small processes, one oblong and sharp, the spinous; the other broader, but thinner, the styloid, both giving attachment to the laxator tympani muscle, and the internal lateral ligament of the lower jaw. Looking now to the internal or orbital surface, we find it to be of a diamond figure, and quite flat and smooth, looking forwards and inwards, and forming the principal portion of the external wall of the orbit; its superior edge, which is rough and thick, articulates with the frontal; its anterior, likewise rough, but thin, with the malar; its inferior smooth, rounded, and free, forms the outer boundary of the spheno-maxillary fissure; and its posterior likewise non-articular, but thin, constitutes the inferior wall of the foramen lacerum orbitale, for the transmission of the several nerves to the orbit. As we proceed downwards and backwards from the orbital processes, we observe a flat portion of the bone terminating below in the roots of the pterygoid processes; it is quadrilateral in shape, forming the posterior boundary of the pterygo-maxillary fossa, and is perforated by two foramina, the one superior, the external opening of the foramen rotundum, and the other inferior and much smaller, the outlet of the Vidian canal. The pterygoid processes alluded to are two remarkable plates of bone, which have received their name from their supposed resemblance to the wings of a bird; they are oblong in shape, and convex anteriorly, where they are only separated by a narrow fissure, into which the sphenoidal process of the palate bone is fitted, but concave posteriorly and divided by a broad groove, occupied by the tensor palati as it runs to its insertion, by the origin of the internal pterygoid, and pterygoid process of the palate bone. Of the two pterygoid plates, the external is the broader, thinner, and shorter; being concave on its outer surface, where it gives origin to the external pterygoid muscle, and convex on its inner, where the internal pterygoid is attached to it. The pterygoid internal plate also arises by two roots from the base of the cranium, one external and long, connecting it to the spinous process; the other short, bending inwards, and forming a thin lamina, which overlaps the side of the vomer; while between them is a depression, triangular in shape, called the scaphoid fossa, from which the tensor palati arises. The inner side of the internal pterygoid plate is slightly convex, and forms the external boundary of the posterior nares, but concave externally where it corresponds to the tensor palati; it terminates in a remarkable hook-like appendage known as the hamular process, round which, but separated from it by a small bursa, the tensor

palati plays, while to its point the pterygo-pharyngeal aponeurosis is attached.

The sphenoid articulates with all the bones of the head, viz. the ethmoid and frontal anteriorly, both parietals and temporals laterally, and the occipital behind; and with five of the face, viz., the two malar, the two palate, and vomer. It has twenty-eight processes—two greater, and two lesser wings; two orbital, and two temporal, two spinous, and two styloid, four pterygoid plates, and four clinoid processes, two hamular and two lesser bones of Bertin, one ethmoidal, one olivary, one basilar, and one azygos. It is perforated by fourteen proper foramina, or seven on either side; viz., the spinous, oval, round, lacerated—orbital, optic, Vidian, and openings into the sphenoidal sinuses, while its common are eight, or four at each side, viz., the anterior lacerated, spheno-maxillary, spheno-palatine, and posterior-palatine, all of which last will be fully discussed in the general description of the cranium.

In the earlier periods of fœtal life, indeed occasionally up to birth, the sphenoid is composed of two distinct parts,—an anterior, consisting of the lesser wings and that part of the body to which they are attached; and a posterior, constituted by the sella turcica, greater wings, and external pterygoid plates, the internal pterygoid forming a distinct process, and connected together by a curved plate of bone. We find that the points of development in a great measure depend on this early arrangement; the lesser wings, and their contiguous portion of the body, having each a separate nucleus, forming four in all; while the greater, with their corresponding half, have each one, making four also. If we now add one for each internal pterygoid process, and one for each bone of Bertin, they will form twelve altogether; but the periods of ossification may vary in making their appearance from the sixth week, to the fifth month. The sphenoidal sinuses do not exist at all in the young subject.

Ethmoid.—This bone, situated in the anterior inferior part of the cranium and forming the greater part of the nasal cavity, is remarkable for its light and spongy character, being composed principally of a series of cells communicating with the meatuses of the nose. In shape it is cuboid, and we may accordingly give it a superior, inferior, and two lateral surfaces, with an anterior and a posterior extremity. Taking first the superior surface, we find it to be quadrilateral, but longer antero-posteriorly than from side to side, supporting, when in position, the bulbs of the olfactory nerves, for the ultimate filaments of which it is perforated by a number of small rounded foramina. In the mesial line an elevated process may be observed, which, from its resemblance to the comb of a cock, has been called the crista galli, on each side of which, but anteriorly, is a fissure about two lines in

length forming the nasal slit, through which passes the nasal branch of the ophthalmic to supply the septum and tip of the nose. The crista galli, which can only be regarded as a prolongation upwards of the vertical plate of the ethmoid, commences behind, at a small triangular notch, and continuing depressed for some distance, gradually ascends upwards and forwards to variable heights, and then abruptly descends, almost perpendicularly, to terminate in two small oval wings, which, diverging anteriorly, unite with similar processes of the frontal to form the foramen cœcum; the crista galli is generally vertical, but may incline to either side; it is always smooth and rounded, and affords attachment to the apex of the falx cerebri. The margins of the superior surface of the ethmoid articulate anteriorly and laterally with the orbital plates of the frontal, and behind with the body and lesser wings of the sphenoid. If we now direct our attention to the sides of the bones, we will find them to be extremely smooth, and hence their name, ossa plana; they are also quadrilateral in shape, but long from before backwards, their external surface corresponding to the inner wall of the orbit, and their internal to the outer of the nose; their anterior margin, extremely short, articulates with the os unguis, their posterior with the sphenoid and palate bones, their inferior with the superior maxillary and inferior spongy, and their superior with the frontal; the suture between the last two being pierced by two foramina, called the anterior and posterior ethmoidal. The anterior extremity of the ethmoid is very irregular in its appearance, displaying several apertures which open into cells; the latter being completed when in situ by the os unguis externally, and the nasal processes of the superior maxillary in front. The posterior extremity, in its general character, is very analogous to the preceding; as in it we find the openings into the posterior ethmoidal cells, but here completed above by the body of the sphenoid, and below by the palate, and here we may observe the extremities of the superior and inferior turbinated bones, with a groove, the superior meatus, dividing them. The inferior surface is the most irregular of any of those we have hitherto described: in the mesial line is placed a thin plate of bone seldom perfectly vertical, known as the nasal lamella, dividing the whole into two lateral masses; the nasal lamella or perpendicular plate, as it is sometimes termed, is thin below, where it is received between the lips of the fissure in the anterior superior margin of the vomer; rough in front, where it joins the septal cartilage and nasal bones; and irregular posteriorly, where it is united to the body of the sphenoid in front of the rostrum, while above, it becomes continuous with the crista galli already alluded to. Between this median septum internally, and the os planum externally, is placed the spongy body

of the bone, consisting of the anterior and posterior ethmoidal cells, separated from each other by a thin transverse septum; the former communicating with the middle, the latter with the superior meatus; while the aspect which they present inferiorly is irregular, and projecting in some parts, so as to overlap and help to close in the maxillary sinus. The two spongy bones which are directly connected to the ethmoid are thin, osseous laminæ, curled upon themselves, convex towards the septum, and divided from each other by a horizontal narrow groove called the superior meatus, into the upper and posterior part of which the sinuses of the sphenoid and cells of the ethmoid open; but of the two, the inferior spongy bone is much the larger, as it extends anteriorly far enough forwards to rest on a ridge of the nasal process of the superior maxillary; and posteriorly, so as to receive a support on a similar crest of the nasal plate of the palate.

The ethmoid articulates with two bones of the head, viz., the frontal and sphenoid; and eleven of the face, viz., the two superior maxillary, two inferior spongy, two nasal, two lachrymal, two palate, and vomer. Its proper holes are those for the olfactory, and nasal nerves; and its common, the anterior and posterior ethmoidal; while it has two processes only, the crista galli, and nasal lamella.

The ossific nucleus of the ethmoid is not visible till the fifth or sixth month, and the cells in its interior are not developed till the fourth year.

THE BONES OF THE FACE.

The FACE, although much smaller in its dimensions than the cranium, exceeds it in the number of bones of which it is composed, being altogether fourteen in number, of which six are double, and two single. The double are the malar, superior maxillary, palate, nasal, lachrymal, and inferior spongy; while the single are the vomer and lower jaw, being all much smaller in size than those of the head, with the exception of the upper and lower jaw bones.

MALAR BONE.—Occupies the superior and external part of the face, presenting the appearance of a curvilinear triangle resting on a broad base, formed by the orbital plate. We may describe it as having two surfaces,—an external and internal; three margins,—a superior, an inferior, and anterior; and four processes,—a superior orbital, an inferior orbital, an internal orbital, and zygomatic. Of these, the external surface, smooth and convex, is perforated at its internal inferior part by a small foramen for the passage of the superficialis malæ nerve, while it likewise affords origin to a few fibres of the masseter below, the zygomaticus major in the middle, and the zygomaticus minor above. The internal surface, concave,

enters into the formation of the temporal fossa, and gives attachment to the temporal muscle, while it is also pierced by a small hole for the temporo-malar nerve. The superior margin, thin and undulating, has attached to it the temporal aponeurosis, and terminates above and anteriorly in a sharp process, called the superior orbital, for articulation with the external angular process of the os frontis, while below and behind it is cut off very obliquely—the zygomatic process—so as to support the zygomatic arch of the temporal bone. The inferior edge, likewise thin, but straight, gives origin to the deep fibres of the masseter; the anterior, concave and sharp, forms the outer and inferior part of the rim of the orbit, terminating below and internally in a tapering point, known as the inferior orbital process, which articulates with the orbital plate of the superior maxillary bone. Bending now backwards and inwards at a very acute angle with the part of the bone already described, is the orbital plate, smooth, concave, and semilunar in shape, bounded in front by its anterior free edge, and behind by a serrated margin, articulating above with the frontal and great wing of the sphenoid, and below with the malar process of the superior maxilla, into which it is received; a slight notch being immediately above this last point of articulation, corresponding to the spheno-maxillary fissure of which it forms the anterior boundary.

The malar articulates with four bones: three of the head—the frontal, sphenoid, and temporal, and one of the face—the superior maxilla. It has four processes: the zygomatic, the superior, inferior, and internal orbital. Its proper foramina are the two already mentioned for the passage of the two small cutaneous nerves; and it has one common, the spheno-maxillary fissure. It is developed from a single point of ossification, which is visible about the seventh week.

Superior Maxillary.—This is one of the most irregular bones of the whole face, and extremely difficult to be properly understood from the number of parts which require to be considered. In order to examine it effectually it should be regarded as a kind of prism standing on its alveolar arch, when it may be divided into the facial, zygomatic, and nasal surfaces, separated by intervening ridges, besides which it presents the nasal process, palatine, and orbital surfaces, each exhibiting peculiar features, which will therefore require an individual description. Commencing first with the anterior edge, we find it to be prominent inferiorly, where it corresponds to the root of the inner incisor tooth, above which it is concave, affording attachment to the frænum of the upper lip; still higher up is a sharp spiculum of bone, the nasal spine, to which are connected the caudate extremity of the alar cartilage, and the sesamoid appendages of the alar cartilages. Proceeding still more superiorly we find the

bone abruptly hollowed out, presenting a deep concavity with the margins smooth and rounded below, but sharp above; this is the nasal notch, which gives attachment to the alar and nasal cartilages; while superiorly is a long process, called the nasal, passing directly upwards, and terminating above in a rough extremity, to articulate with the internal angular process of the os frontis. The nasal process presents for description an external and internal surface, with an anterior and posterior edge. Of these the external surface, smooth and slightly convex, has attached to it the long head of the levator labii superioris alæque nasi, the orbicularis palpebrarum, and tendo oculi, while the internal surface is rough, and presents two remarkable horizontal ridges on it; one below, near its root, to support the inferior spongy bone, the other a little above its centre for the middle, while the depression which separates them corresponds to the middle meatus of the nose; the anterior margin thin and sharp, articulates with the nasal bones; the posterior, much thicker and deeply grooved inferiorly, forms the greater part of the nasal duct, the os unguis articulating with the posterior lip of the groove. The undulating ridge of bone above alluded to, as formed by the nasal notch and symphisis of the two superior maxillary bones, of course excluding the nasal process which has only here been described as an appendage or continuation of it, forms the line of demarcation between the nasal and facial surfaces, while the external is formed by the jugal ridge which commences below at the third molar tooth, where it is but slightly elevated; as it ascends it becomes gradually more prominent till it terminates in a sharp point above; here it bifurcates into two laminæ—one sharp and thin, which runs forwards and inwards to the anterior edge of the orbit, where it is gradually lost; the other thicker, more elevated and irregular, which passes backwards and inwards towards the spheno-maxillary fissure, where it ceases abruptly; between the two is circumscribed a rough depressed triangular surface for the reception of the malar bone. The jugal or external ridge separates the facial from the zygomatic surface and affords origin to the anterior fibres of the buccinator. The last of those ridges lying posteriorly and internally is very irregular in its outline; it is generally grooved for the posterior palatine canal, and divides the zygomatic from the facial surface. Directing now our attention to those surfaces we find that the facial is very extensive, and generally speaking concave, consisting of two fossæ—one anterior and inferior, small and quadrilateral, called the incisive or myrtiform; the other superior and external, large, concave, and likewise square—the canine. Of these the myrtiform (so called from its shape) bounded below by the incisor teeth, above by the lower part of the nasal notch, in front by the symphysis, and behind by

the prominence of the canine tooth, gives origin to the depressor labii superioris alæque nasi, whilst the canine, limited below by the alveoli of the two anterior molar teeth, above by the edge of the orbit and articulation of the malar bone, in front by the elevation of the canine tooth and nasal notch, and behind by the jugal ridge, affords attachment to the compressor nasi internally, to the levator anguli oris externally, and to the short head of the levator labii superioris alæque nasi superiorly; while the infra-orbital hole lies between the origins of these two last muscles, directed downwards and forwards, and through it emerges the vessels and nerves of the same name. The zygomatic portion of the bone, situated posteriorly, is bounded below by the two last molar teeth, above by the edge of the orbital process, externally by the jugal ridge, and internally by its articulation with the palate. The inner part of its surface, prominent and convex, called the tuberosity, is perforated by several small foramina for the dental nerves and vessels, and likewise marked by a small groove, corresponding to the pterygo-palatine canal, while the outer is smooth and concave, and gives origin to the buccinator muscle. If we now direct our attention to the nasal surface, we will observe it to spring almost perpendicularly upwards from the palate plate, being smooth and concave inferiorly, where it corresponds to the outer wall of the inferior meatus, and perforated above and behind by a large foramen which opens into the antrum of Highmore. This cavity, the antrum Highmorianum, occupying the greater part of the body of the bone, is of a pyramidal shape, with the base turned internally, the apex externally, bounded above by the orbital process; in front and externally by the facial, behind by the zygomatic, below by the alveolar, while internally it is almost completely closed in by four bones—the lachrymal anteriorly, the palate posteriorly, the ethmoid above, and inferior spongy below; these, by their apposition, convert the large foramen into a mere chink, which is further constricted by the mucous membrane, which is here thrown into loose folds around its edges.

Having now taken a review of the circumferential aspects of the bone, it only remains for us to examine the remaining portions, consisting of the orbital and alveolar processes, with the naso-palatine portion. Of these the orbital process, triangular in shape, flat and smooth, looking upwards, forwards, and outwards, is marked by a deep groove posteriorly, which forms the commencement of the infra-orbital canal, and is limited by three margins: an internal, thin, irregular, and beveled off to articulate with the palate bone behind, with the os planum of the ethmoid in the centre, and a small portion of the lachrymal in front, while it is notched more anteriorly for the commencement of the nasal duct; its external edge is smooth and

rounded, where it forms the internal boundary of the spheno-maxillary fissure ; two notches being, however, visible in it anteriorly, one for the infra-orbital canal, the other for the termination of the fissure itself; its anterior margin, slightly concave upwards, presents for its external two-thirds a rough surface for articulation with the malar bone, while its internal is smooth, rounded, and free. The naso-palatine portion of the bone, situated inferiorly and internally, presents three surfaces for examination, viz., a superior, an inferior, and internal. Of these the superior, forming the floor of the nose, is concave from side to side, and also from before backwards, but broader behind than in front, bounded internally by a thin irregular lip, known as the nasal crest, while a little external to this process, and half-an-inch from its anterior extremity, is a small foramen, called the anterior palatine, communicating below with the incisive fossa, and giving passage to the naso-palatine nerve. The inferior surface presents a remarkable contrast to that already described, being of a triangular shape, bounded externally by the alveolar process, internally by the symphysis with its fellow of the opposite side, and posteriorly by its junction with the palate ; it is concave and rough for the attachment of the mucous membrane of the hard palate, while externally, where it unites with the alveolar arch, a groove appears for the passage of a branch of the posterior palatine nerve arching forwards to anastomose with the naso-palatine in the incisive fossa. Turning now to its internal surface we observe that it is triangular in shape, with the base anteriorly and the apex posteriorly, marked by numerous elevated lines and depressions, vertical in direction, which dovetail with similar ones of the opposite side, constituting the articulation called harmonia; while near the anterior extremity a deficiency called the incisive fossa, is found to exist from the bones not coming in contact, which occupies about the inferior third of the bone in thickness, and then bifurcates into two distinct canals called the anterior palatine, which fork out like the letter Y and open on the floor of each nostril ; the incisive fossa contains the naso-palatine ganglion described by Jules Cloquet.

The superior maxillary articulates with two bones of the head—the frontal, and ethmoid, occasionally with the sphenoid; and with all the bones of the face, except the inferior maxillary. It has eight processes—the orbital, alveolar, palatine, zygomatic, malar, nasal process, crest, and spine. Its proper foramina are four—the anterior palatine canal, foramen antri, infra-orbital, and dental; and its common the same number—the foramen incisivum, posterior palatine, nasal duct, and spheno-maxillary fissure. This bone is very early in its development ; ossification being apparent in its alveolar arch

about the fifth week, while another osseous point is said to exist for that portion of the bone which supports the incisor teeth. The suture which connects the latter to the body of the bone has been occasionally observed, even in the adult, running from the septum between the outer incisor and canine tooth inwards to the back part of the incisive fossa, and afterwards extending upwards to the nasal process, where it is gradually lost. This, on either side, would circumscribe a segment corresponding to the intermaxillary bone in the lower animals, and its arrest of union would account for the occurrence of double harelip. A second fissure is sometimes seen extending from the edge of the orbit to the infra-orbital foramen, and this can only be considered as a continuation of the canal of the same name, which in early life is always incomplete. In the fœtus, the superior maxilla is remarkable for the extreme shortness of its vertical measurement arising from the non-development of the antrum; and its great length from before backwards, owing to the teeth not having as yet emerged from the tuberosity; while in old age the loss of those instruments of mastication bestow upon it something of a similar character. Among the many advantages said to result from the existence of a cavity in this bone, the following would appear to be the most rational, viz., increased lightness, less liability to fracture, additional resonance to the voice, and greater amount of secretion, owing to the mucous membrane being stretched over a larger extent of surface.

Palate Bones are found lying immediately behind the superior maxillary, and have been divided into two parts,—a horizontal and vertical plate, uniting with each other externally, almost at a right angle. Of these the horizontal plate, irregularly quadrilateral, presents two surfaces, a superior and an inferior; and four margins, an anterior, a posterior, an internal, and external. The superior surface or nasal, smooth and concave from side to side, forms the floor of the inferior meatus of the nose; and is bounded internally by an elevated lip, which articulates with the vomer, and which terminates posteriorly in a sharp-pointed process, the spine, which gives attachment to the tensor palati and azygos uvulæ muscles; while the inferior, grooved from side to side, and covered with the mucous membrane of the palate, is pierced by a foramen externally and posteriorly for the transmission of the posterior palatine nerve and artery, one or two smaller foramina sometimes also being visible in the posterior part of the bone, for the accessory twigs of the same nerve to supply the neighbouring structures. Of its margins the internal is short, thick, and rough, for articulating with its fellow of the opposite side; the posterior, smooth and concave, has attached to it the soft palate; the anterior rough for uniting with the superior maxilla; while the ex-

ternal, stretching backwards and outwards, terminates in a pyramidal process, called the pterygoid, the base of which is turned inwards, and its apex outwards, presenting on its upper surface three well-marked grooves, the central of which forms the greater portion of the posterior palatine canal, while the two lateral, not so well marked, articulate with the internal and external pterygoid plates, between which it is firmly wedged. If we now direct our attention to the vertical plate, we will find it to be likewise quadrilateral, but long from above downwards, and thinner than the preceding. It accordingly presents for examination two surfaces, an internal and external, and four margins, an inferior, an anterior, a posterior, and superior. On the internal surface we observe two horizontal ridges, the inferior ridge being the best marked, to support the posterior extremity of the inferior spongy bone; while the superior, only visible towards the anterior part, has the middle spongy resting on it; the groove which separates them is concave from above downwards, is extremely smooth, and corresponds to the middle meatus of the nose. The external surface, convex, and also smooth, forms the internal boundary of one of the most important fossæ at the base of the cranium, called the spheno-maxillary, containing the superior maxillary nerve, Meckel's ganglion, and internal maxillary artery. Of its four margins the inferior becomes continuous with the horizontal plate nearly at a right angle, while its anterior very thin, articulates below with the superior maxilla, and above with the os planum of the ethmoid; the posterior, grooved for the palatine canal, unites with the pterygoid plates; the superior is remarkable for being surmounted by two processes,—one anterior, and much more elevated than the other, called the orbital; the other posterior, thin and sharp, known as the sphenoidal; a deep notch, forming two-thirds of a circle, divides those processes from each other, and across the interval between them, the body of the sphenoid is thrown, thus converting it into a foramen for the passage of the spheno-palatine nerve, and artery. The anterior or orbital process is of a conical figure, and presents two non-articular facettes; one external corresponding to the spheno-maxillary fissure; the other, superior and anterior, forming part of the floor of the orbit; and three articular,—one in front and above, to unite with the orbital plate of the superior maxilla; one behind and above, for the body of the sphenoid; and one internally for the ethmoid; an imperfect cell is usually found in this process, which communicates with the sphenoidal sinus. The posterior process is thin and prolonged backwards to articulate with the roots of the pterygoid plates as they spring from its body, and hence its name,—the sphenoidal.

The Palate unites with two bones of the head,—the ethmoid and

sphenoid; and four of the face—its fellow of the opposite side, the superior maxilla, the inferior spongy, and vomer. It has seven processes,—the horizontal, and vertical plates, the pterygoid, crest, spine, orbital, and sphenoidal; while its foramina are, two proper,—the posterior palatine hole, and its accessory,—and two common—the spheno-maxillary, and spheno-palatine canal. It is developed from a single point of ossification, which is visible about the sixth week at the external inferior part, or the junction of the two plates with the pterygoid process; while in the fœtus its vertical measurement is less than its transverse, and it is also much broader comparatively in the antero-posterior direction.

NASAL BONES are two in number, forming the anterior part of the root of the nose. In figure they are oblong, narrow and thick above, but broader and thinner below, and are of a variable shape in different individuals: presenting for examination an anterior and a posterior surface, a superior and an inferior extremity, and an internal and external margin. Of these the anterior surface is smooth, and corresponds to the pyramidalis nasi; while the posterior, concave and marked by a groove for the nasal twig of the ophthalmic, is covered by the pituitary membrane; the superior extremity is rough, thick, and serrated to articulate with the internal angular process of the os frontis; the inferior, sharp, thin, and sometimes notched, is connected to the nasal cartilages; the internal edge is thick and beveled off, so that, when they come in contact anteriorly, a groove is left between them posteriorly to receive the spine of the frontal, and perpendicular plate of the ethmoid; its external is almost straight and smooth to unite with the nasal process of the superior maxillary.

The nasal articulates with two bones of the head,—the ethmoid and frontal; and three of the face,—the superior maxillary, vomer, and its fellow of the opposite side. It is developed from a single point of ossification, which is visible about the the eighth or ninth week.

THE OSSA UNGUIS, or LACHRYMAL are found in the anterior part of the inner wall of the orbital cavity. Extremely thin, like paper and quadrilateral in shape, they accordingly present two surfaces,—an internal and external; and four margins,—a superior, an inferior, an anterior, and a posterior. The external surface is marked by a perpendicular ridge, which divides it into two portions,—an anterior and posterior; the former being deeply grooved and porous, and entering into the formation of the nasal duct; while the posterior, larger and slightly concave, assists in completing the inner wall of the orbit, the ridge which separates them giving origin to the tensor tarsi muscle. The internal surface is slightly concave, owing to a depression which exists on it, corresponding to the ridge on the opposite

side; it closes in anteriorly, the middle meatus, and posteriorly, the ethmoidal cells. Its anterior margin is nearly straight, for articulation with the nasal process of the superior maxillary; while its posterior, thinner and shorter, unites with the os planum of the ethmoid; its inferior, slightly denticulated, is joined to the orbital plate of the superior maxillary, sending downwards and backwards a long process to meet the inferior turbinated bone: while the superior, the shortest and thickest of the whole, articulates with the frontal.

The lachrymal, articulates with two bones of the head: the frontal, and ethmoid; and two of the face, the superior maxillary, and inferior turbinated. It is developed from a single point of ossification, which is visible from the thirteenth to the fourteenth week.

Inferior Turbinated Bones are two, one on each side of the cavity of the nose, on its outer wall immediately below the ethmoid; they are very thin, but rough, owing to the numerous grooves with which they are indented, for the veins and arteries which ramify on them, under the pituitary membrane. Oval in figure, they present for examination an internal, and external surface; an upper, and lower margin; and an anterior, and a posterior extremity. Of these the internal surface is convex and turned towards the septum, from which it is usually separated by a narrow interval, but sometimes is in contact with it; while the external is concave, and forms a large portion of the inferior meatus; the superior border is irregular, very thin anteriorly, where it rests on the inferior horizontal ridge of the nasal process of the superior maxilla, but presenting more posteriorly an elevated portion, called the lachrymal process, slightly grooved, forming a part of the nasal duct, and articulating with the os unguis; still more posteriorly it is bent downwards and outwards into a small triangular plate, which lies against and assists in closing the antrum Highmorianum; above it articulates with the os planum of the ethmoid; and still farther back, it rests on the inferior horizontal ridge of the palate bone; the inferior margin, thicker, free and curved outwards, lies at very variable distances from the floor of the nose; while its anterior extremity, much broader than its posterior, indicates at once the side of the nose to which it belongs.

The inferior turbinated articulates with one bone of the head,—the ethmoid, and three of the face,—the os unguis, superior maxillary, and palate. It is developed from a single point of ossification, which is visible from the fifth to the sixth month.

Vomer is a single bone, placed in the median line, and forming the posterior part of the septum nasi; it is usually perpendicular, but may incline to either side, and this sometimes in a very remarkable degree. In figure it is quadrilateral, presenting two surfaces,

corresponding to either nostril, marked by some small foramina and grooves, for the passage of veins and nerves, and four margins,—a superior or sphenoidal, an inferior or maxillary, an anterior or ethmoidal, and a posterior or pharyngeal. The superior border is remarkable for an elongated fissure for the reception of the azygos process of the sphenoid, and for its two alæ spreading out on either side to articulate with corresponding grooves on the under part of the body of that bone ; its inferior edge, thin and sharp, is received into a cleft formed for its reception by the union of the palate and maxillary bones of opposite sides ; its anterior margin, fissured above, receives the nasal lamella of the ethmoid ; it is rough and serrated below, where it unites with the septal cartilage, while its posterior edge, sharp, thin, and concave, forms the line of division between the posterior nares.

The vomer articulates with two bones of the head,—the ethmoid and sphenoid ; and four of the face,—the two palate, and two superior maxillary. It is developed from a single point of ossification, which makes its appearance at its anterior margin, about the eighth week, but at birth it is merely a bony groove, which embraces the cartilage in front, and its complete development proceeds very slowly.

Inferior Maxilla is a single bone, and has been compared in shape to a horse-shoe ; to examine it properly it should be divided into a body, sides, rami, coronoid, and condyloid processes. Of these the body, which is the most anterior part, is square in its outline, presenting an anterior and a posterior surface, and an upper and a lower margin ; its lateral parts becoming continuous with the rami at each side, at a very obtuse angle. The anterior surface convex, shows in the mesial line a vertical elevation indicating the point of union between the two portions of opposite sides, and to this the term symphysis menti has been attached; it terminates below in a prominence known as the genial process; external to the symphisis, and extending outwards nearly to the mental hole, is a superficial depression for the origin of the quadratus menti, while above it, is another, smaller, and not so well-marked, limited externally by the prominence of the canine tooth, called the myrtiform or incisor fossa, from which arises the levator labii inferioris. The posterior surface is concave and much smoother, a mere line marking the junction between the two bones of opposite sides; to this the frænum linguæ, or mucous fold connected to the under surface of the tongue is attached, while near its lower part we may observe four tubercles known as the genial eminences ; from the two superior of which the genio-hyoglossi of opposite sides arise, and from the two inferior, the genio-hyoidei ; on either side of the two last, but a little lower down, is a slight depression, oval in shape, called the

digastric pit, into which the muscle of that name is inserted; the upper edge of the body is perforated by four foramina for the incisor teeth, the margins of each being marked by slight depressions, but more deeply on the anterior than the posterior surface; while the inferior border is rounded, prominent, and subcutaneous. Turning now the sides of the lower jaw, we find them to curve backwards and outwards, as far as the angle where they unite with the ascending ramus; their external surface is slightly convex, and at its anterior part, a little below its centre, from above downwards, is a round foramen, known as the mental, which gives passage to the nerve, and artery of the same name; an oblique line, commencing below this hole, passes upwards and backwards, to terminate in the posterior lip of the coronoid process; to this line is attached, anteriorly, the triangularis oris, whilst behind this muscle it is crossed nearly at a right angle by the facial artery; the internal surface is very irregular, and presents a ridge similar to that on the outside, but more elevated, passing from before and below, upwards and backwards, to terminate in a spur-like process, overhanging the dental foramen; this has been called the mylo-hyoid ridge, which gives attachment by its two anterior thirds to the muscle of that name, and by its posterior third to the superior constrictor of the pharynx; above it, but anteriorly, is a superficial depression for the sublingual gland, and below it, but posteriorly, another for the submaxillary; a slight groove is likewise found inferior and parallel to it, which lodges a small nerve, the mylo-hyoid, a branch of the inferior dental, for the supply of that muscle; the upper margin of the side, studded with the depressions for the molar teeth, is curved inwards, particularly at its posterior part, and terminates in a shallow groove, which is gradually lost on the anterior edge of the coronoid process; the inferior edge is rounded and curved outwards. The rami join the sides of the bone at variable angles, according to the period of life; in the very young the angle can scarcely be said to exist, but with succeeding years it gradually becomes more developed, approaching, at the adult period, very closely to a right angle; but with declining life it again diminishes, and as the teeth decay and fall, it by degrees becomes more obtuse, again assuming in old age all the characteristic features of childhood. On examining the sides as they appear in the adult, they are seen to be quadrilateral, presenting two surfaces, an internal and external; and four margins, an anterior, a posterior, an inferior, and superior. The external surface is generally flat, but rough in order to afford firmer attachment to the masseter muscle, the anterior portion of which is inserted into the lower part in front of its angle, while the aponeurotic fibres of its posterior part, gliding beneath the other, are firmly implanted

into the upper part of the side, as high as the sigmoid notch; the internal surface, on the other hand, is very irregular; the angle and the parts adjacent being elevated and rough for the insertion of the internal pterygoid, and stylo-maxillary ligament, while a little above it is the large dental foramen, leading obliquely downwards and forwards into the dental canal, for the transmission of the dental vessels, and nerves for the supply of the teeth. The orifice of this canal is bounded superiorly and internally by a sharp process called the spur, which gives attachment to the internal lateral ligament of the jaw; above the spur, but posteriorly, the bone is concave and smooth, where the internal maxillary glides beneath it to reach the pterygoid space; while more anteriorly it is elevated and rough, for the attachment of the buccino-pharyngeal aponeurosis. We have already stated that the alveolar process posteriorly is prolonged as a groove, forming the anterior edge of the coronoid process: this groove inferiorly gives attachment to the buccinator muscle, while above it affords insertion to the anterior fibres of the temporal. The posterior edge of the ascending ramus is rounded, slightly concave, and imbedded in the parotid gland, while the superior presents two remarkable processes, the coronoid anteriorly, and condyloid posteriorly, which are separated by a depression nearly semicircular, with margins exceedingly sharp, known as the sigmoid notch, which gives passage to the masseteric nerve, and artery, for the supply of that muscle. The coronoid process, triangular in shape, with the base below and the apex above, the latter curved outwards and backwards, is imbedded in the tendon of the temporal muscle, which it splits like a wedge; while the condyloid, broad from side to side, and covered superiorly with cartilage, is supported by a constricted neck, which is grooved anteriorly and internally, for the insertion of the external pterygoid muscle, while it is rounded and smooth behind, and encircled by the attachment of the capsular ligament, which connects it to the glenoid cavity above.

The inferior maxilla articulates with one bone of the head, the temporal, but with none of the face; it has two proper foramina, the dental and mental; and its processes are two, the coronoid and condyloid. It has also two points of ossification for each lateral portion,—one for the mass of the bone in general, and the other for the inner border of the dental groove, ossification taking place very early, generally from the fourth to the fifth week, while the alveolar portion, which we have stated to be distinct, becomes united to the other about the seventh or eighth. We have already alluded to the changes which it undergoes at the several periods of life, modifying the character of its angle, and to this we may merely add that the ridges we have described on the outer and inner surfaces of its sides,

stretching obliquely downwards, forwards, and inwards, seem to divide them into two distinct parts,—a superior or alveolar, constituting about two-thirds in depth of the bone anteriorly; and an inferior or basilar, the foundation on which the entire bone appears to be built.

THE TEETH.

The teeth are divided into permanent and into temporary, or deciduous; and are variously considered to appertain to the neural and dermal skeletons; they are sixteen in number in each jaw, and divisible into four incisors, two canine, and ten molars. Each tooth has a crown, neck, and fang, the first being that portion which is free above the gum; the second that which is surrounded by the fibro-mucous tissue; and the third that which is imbedded in its proper alveolus, these several parts undergoing modifications resulting from age, position, use, &c. although strictly formed according to a single type.

Incisors.—In these, the crown is somewhat triangular in shape, but constricted towards the neck, flat or convex from side to side on the anterior surface; deeply excavated on the posterior, and gradually bevelled off superiorly to a chisel edge. The two central are the larger, those of the upper jaw predominating in size remarkably over those of the lower, while the neck is constricted and rough, with numerous small apertures for the transmission of vessels; the fang or root, conical in shape, is planted in the alveolar depression, and presents at the extremity an opening for the transmission of the nutritious artery, and a branch of the dental nerve; a vertical section revealing a cavity within, corresponding in outline to the tooth, and occupied during life by the dental pulp.

Canine, Laniares, or Cuspidati.—In these, the crown is constricted superiorly into a blunted point; they are very convex anteriorly, and cut off from below, upwards and forwards, on the posterior surface; the neck is also contracted in size, and surrounded by the gum, while the fang, thick, strong, and much prolonged, is planted in the alveolus, its gradual increase from point to neck protecting the artery, and nervous filament from pressure.

Molars.—Are five in number, the three posterior on each side being true molars, or multicuspidati; and the two anterior false molars, or bicuspidati, the latter presenting a crown with a double tubercle superiorly,—the external being the more elevated of the two; they are convex both on their internal and external surfaces, and short from above downwards, supported by a constricted neck, while the fang is still single, with a linear depression on both aspects,

showing a tendency to that future division which sometimes exists in those of the upper jaw, especially in the posterior pair. In the true molars the crown is square, and surmounted by three or four tubercles; they are also convex on both surfaces, and generally exhibit two linear depressions, running from above downwards, shaping the crown like a wool-pack, while the neck is constricted and short, the fangs varying from three to four, with a corresponding number of neural and vascular foramina. Occasionally in the lower set, two roots only occur, a divergent excurvation existing which increases their security; but, according to our observation, this arrangement may be found much more frequently in the upper set, although the contrary opinion is usually entertained. The pulp cavity is figured like a Maltese cross, and is large and well-marked.

STRUCTURE.—A tooth consists of three hard tissues, and a central vascular matrix; those tissues are the enamel, which surrounds the crown; the dentine or tooth ivory, intermediately placed between the enamel and the pulp cavity; and the crusta petrosa, or cementum, holding the same relation to the fang, as the enamel to the crown. Of these three structures the *enamel*, the hardest in the human body, is smooth on the external surface, more rough internally, and always thicker on the summit than on the sides of the crown, which it wholly surrounds. In order to examine its structure properly, sections must be prepared for the microscope, both longitudinal and transverse, when it will be seen to consist of a series of hexagonal fibres, with their opposed surfaces mutually corresponding, one extremity being free, while the second rests on and is attached to the surface of the dentine. Maceration in acid proves these fibres to be merely an organic sheath, containing a crystalline deposit (fluoride of calcium), and consequently a modified cell structure. We have been unable to detect any wave in the enamel fibres, but an obliquity, in many cases amounting to a single curve, is often distinctly visible.

Dentine.—This structure, giving form and strength to the tooth, consists of tubular fibres, commencing by large open extremities on the surface of the pulp cavity, from whence they radiate and divide dichotomously in their course to gain the enamel, to which they are attached by filamentous extremities; but where they reach the crusta petrosa, they are the efferent tubes of osseous lacunæ, which they form by dilatations of their own cavities. Each tube has a proper osseous wall, granular when examined with a high power, and much denser than the intertubular structure in which the cylinders are imbedded in their course. The tubes present two systems of curves,—primary and secondary; the resulting angles, by alternately intercepting the light, producing their apparently baccated condition. The object of these osseous vessels appears to be for the purpose of conveying the

elements of nutrition to the most remote portions of the dental structure, thus becoming similar in function to the Haversian canals of long bones, while they likewise, by their direction and numerous incurvations, produce strength, and confer a certain degree of elasticity on the tooth structure.

Cementum, crusta petrosa, or *tooth-bone*, surrounds the root, lines the vascular canal for some distance, and at the emergence of the tooth covers the enamel with a thin stratum. It is thickest at the extremity of the fang, and presents lacunæ and canaliculi exactly similar to those of the bones of the true skeleton.

Development.—This process consists of four stages termed the papillar, follicular, saccular, and eruptive; but it will be preferable in an anatomical work of this kind merely to present a general view of the subject, referring to treatises on structural anatomy for more exact information. (See Müller by Baley, Todd and Bowman's Physiology of Man, and Dr. Carpenter's beautiful work on General Physiology.)

It may be stated generally, that about the sixth week the superior maxillary bone presents a shallow groove anterior to the palate-plate or its rudiment, lined by mucous membrane, and within this a series of papillæ are developed, constituting the first stage; again, within the same sulcus transverse folds, the rudiments of the future alveolar septa, are produced, and these, separating the papillæ, represent the second or follicular stage; while, finally, from the margins of the follicle, opercula or coverlids are developed, overlapping the papillæ, thus forming closed saccules, or the third stage. The crown of the tooth is first developed from the dentinal pulp, and the enamel from the second distinct but similar structure, the ossifying surface being the columnar epithelium of the enclosed mucous membrane; while the cementum is a subsequent formation, probably derived from a distinct membrane, which, from the fact that the enamel is covered by a thin layer at the period of eruption, would seem to line the sac external to the pulp of the last-described structure. Taking these changes more in detail at the sixth week of fœtal life, the upper jaw presents a prominent mucous fold anteriorly,—the rudiment of the lip; and internal to this, a second,—the nascent palate, separated from each other by a groove, but all receiving a common covering from the proper mucous membrane, while a little later a ridge is developed from the floor of the groove anteriorly,—the rudiment of the external alveolar arch. The order of parts from before backwards would therefore be, first, the lip; second, a depression; third, the external alveolar ridge; fourth, primary dental groove; fifth, fold representing the internal alveolar border; and, sixth, the palate. Again the order of primary formation would be

as follows:—papilla of first deciduous molar, seventh week; of canine, eighth week; of incisor—the central having precedence—ninth week; and second molar, tenth week. When the germs of all the deciduous teeth are perfected, those in the lower jaw being prolonged, a little later, in fact, until the eleventh week, the follicular stage is completed; and at the thirteenth week the closure of the follicles, and their conversion into saccules are accomplished. During the fourteenth and fifteenth weeks, the primary dental groove is closed, but a portion nearer to the surface, the secondary dental groove, remains open, processes from the dental sac being prolonged into it to form the saccules of the permanent teeth; these are styled cavities of reserve, the prolongations for the incisors, preceding those for the canine and molars. The secondary dental groove is now closed, and at the fifth month papillæ are developed, producing saccules similar to the primary forms; these likewise recede from the surface of the gum, and lie internal to the deciduous sacs. The first permanent molar is developed not in the secondary dental groove, but by a papilla, situated in the posterior extremity of the primitive sulcus; the reserve cavities of the two last molars being situated superficial to the former in the secondary groove, a sufficient distance being ensured for their development by the elongation of the jaws backward. Prior to that period, the first permanent molar is imbedded in the coronoid process and tuber of the maxillary bones, and is peculiar in being developed in the primitive dental groove, like the milk-teeth, from which, however, it differs in not being deciduous; while the third molar, or wisdom-tooth, does not reach its proper range with the other teeth until the eighteenth or twentieth year.* The stage of eruption is accomplished by absorption from the continued growth of the tooth from below, and occurs in the following succession:—The four central incisors about the seventh month, those of the lower jaw first; lateral incisors next appear, between the seventh and tenth months; anterior molars at the commencement of the second year; the canine between the fourteenth and twentieth months; and the posterior molars from the eighteenth to the thirty-sixth month. The permanent teeth appear at the following ages (see *Carpenter's Physiology*):—

Central Incisors developed at		8 years.
Lateral Incisors	,,	9 ,,
First Bicuspid	,,	10 ,,
Second Bicuspid	,,	11 ,,
Canines	,,	12–12½ years.
Second Molars	,,	12–14½ ,,

* Goodier in *Edinburgh Medical and Surgical Journal.*

The second series of teeth become requisite, in consequence of the increase in the size of the jaws, and it is on this account that the primary set are deciduous. They are considered merely as calcified cell transformations of the elements of the mucous membrane, similar to corneous tissues; they differ in many respects from the bones of the true skeleton, in being exposed and devoid of periosteum, and in containing chondrine instead of gelatine; they are likewise remarkable for the amount of fluoride of calcium found in the enamel; in being deciduous; and, with few exceptions, not lasting the life of the individual where senility is much prolonged. Certain circumstances would seem to strengthen the opinion of their being more nearly allied to the dermal structures, and amongst the more obvious are the attachment of the teeth to the jaw by ligaments, as in the lophius piscatorum, and their arrangement on the tongue, palate, and gills of the salmon, and the similar organization of the beak in birds.

Os Hyoides.—This bone is single and situated in the anterior part of the neck, between the larynx and tongue. It is parabolic in shape, or rather, it resembles in a great measure the small Greek upsilon, and hence its name. In order to examine it, we will divide it into a body, two lesser cornua or appendices, two greater cornua, and two cartilaginous nodules at the extremities of these last. Of these, the body is quadrilateral in shape, presenting two surfaces,—an anterior, and posterior; and two margins,—a superior and inferior. The anterior surface, more prominent below than above, is rough, convex, and subcutaneous; while the posterior is deeply concave, filled with a mass of condensed cellular tissue, at one period described as a gland, the duct of which was said to have opened on the upper and posterior part of the tongue; the lower edge, more prominent than the upper, has inserted into it the sterno-hyoid internally, and the omohyoid externally, while the superior margin, curved backwards, gives attachment to the thyro-hyoid membrane, and to a strong ligamentous structure of a yellowish colour, which is prolonged into the centre of the tongue,—the analogue of the lingual bone in the lower class of animals, as well as to the mylo-hyoid, genio-hyoid, and genio-hyoglossus, the aponeurosis of those muscles being continued over the anterior surface; the lateral extremities of the body become continuous with the greater cornua at an obtuse angle, the junction between them being sometimes cartilaginous and sometimes osseous, and, at their point of union, but situated superiorly, is the appendix, or lesser cornu, conical in shape, directed upwards, backwards, and outwards, of variable length, affording attachment to the stylo-hyoid muscle and ligament, as well as to small muscular slips of the hyoglossus, and middle

constrictor of the pharynx. The greater cornua stretch backwards and outwards, diverging from each other, and terminate posteriorly in a cartilaginous tubercle, which in the natural condition of the parts occupies a space bounded above by the lingual artery, below by the superior thyroid, and posteriorly by the external carotid; these processes of the bone differ essentially from the body, being much smaller and rounder, and tapering gradually off as they proceed backwards; they give attachment to the thyro-hyoid muscle and membrane below, to the hyoglossus and middle constrictor above, and by their cartilaginous extremity to the thyro-hyoid ligament.

The os hyoides has no immediate connexion with any other bone of the skeleton, but this rule is occasionally liable to exception, as the styloid process of the temporal has been sometimes observed to articulate with it. This, however, is an extremely rare occurrence, and would appear to depend on the ossification of the stylo-hyoid ligament—a structural change which it is exceedingly prone to undergo in a partial degree. It is developed from five ossific points,—one for the body, one for each cornu, and one for each appendix, these points being seldom or ever found to be united at birth, but are separated by cartilaginous intervals, which are sometimes persistent for a lengthened period.

Having now described the several bones of the cranium and face in detail, we shall next proceed to an examination of them as a whole—a subject, no doubt, of much complexity, but at the same time of paramount importance, as a thorough acquaintance with the several regions, fossæ, and foramina is essentially requisite in order properly to understand the intricate anatomy of the head and neck. It may be necessary here to remark that it is our intention to confine our observations for the present to the cranium, excluding altogether the face, which in general may be said to form about one-fourth of the whole mass of the skull; but as this proportion between the two is not always exact, varying, as it is known to do, in the several races of man, physiologists have attempted to define the amount of the capacity of an individual, by making the relative size of the cranium and face the standard of intellect, a course of proceeding which, to say the least of it, appears to be exceedingly problematical. Amongst the various theories which have been propounded on this subject, it may be perhaps necessary briefly to allude to that of Camper; he proposed as a measurement of the intellect the facial angle, which he suggested should be formed by dropping a vertical line from the most prominent part of the forehead to the incisor teeth of the upper jaw, and another drawn from the last-named point to the tube of the ear. The angle included between these two

lines has been found to vary, being from 80° to 85° in the European, from 70° to 75° in the Mongolian, from 60° to 65° in the Negro, about 40° in the chimpanzee, and 30° in the ouran-outang. Now the theory advocated by Camper is this—that the nearer the angle formed by the concourse approached to a right angle, the greater would be the amount of intellectual capacity. This idea is not only supported by the foregoing facts, but likewise corroborated by the views inculcated by comparative anatomy, which teaches us that in the ascending scale of intellectual development the face and cranium are in an inverse ratio to each other, and that the one must always be increased at the expense of the other. We also find the skull comparatively larger in the child than in the adult; while, as the rule, that of the male, is always much better developed, than that of the female.

The Cranium, when its facial appendage is removed from it, is ovoid in figure, more expanded behind than in front, flattened on its inferior surface anteriorly, as well as on its sides, while superiorly it is smooth, rounded, and convex. It does not necessarily follow that its two lateral portions should exactly correspond in size, as variations exist more or less obvious in all; but where the deviation is very striking it has been generally found that some cerebral affection had been evidenced during life. As it is a hollow cavity, we must give it two surfaces,—an external, and internal—the one in its general character convex, the other concave. We will begin with the first.

The exterior of the skull, may be divided into the sinciput or frontal region; the bregma or vertex, with the lateral regions or temporal on each side; the occiput, and true base. Of these the sinciput, occupying the anterior superior part of the cranium, formed solely by the frontal bones, is smooth, convex, and covered by the occipito-frontalis, bounded anteriorly by the superciliary ridges, and the suture between the frontal and nasal bones; posteriorly by the coronal suture; and laterally by the temporal ridges. Immediately above the edge of the orbit, we observe a small hole, sometimes a mere notch, for the supra-orbital nerve and artery; and higher up a slight transverse depression, above which it becomes again prominent, constituting the frontal eminences, the points where the first ossific nuclei are deposited. Between these two elevations, may generally be seen the imperfect remnant of the suture where the opposite bones were disunited in early life, terminating below and in front in the spine for the support of the nasal bones, and behind by the posterior superior angle, which in fœtal existence were rounded, as already alluded to in the description of the separate bone, giving rise to a deficiency in the osseous structure, termed the anterior

superior fontanelle. Immediately behind the sinciput is the bregma, or vertex; which is of a quadrilateral shape, bounded anteriorly by the coronal suture, behind by the lambdoidal, and laterally by the temporal ridges. It also presents in the mesial line a suture, —the sagittal, which lies between two well-marked eminences on either side the parietal, while two small foramina are generally found near the posterior part of the suture, for the transmission of a small vein to communicate with the longitudinal sinus; and at the same place, in fœtal life the posterior fontanelle exists from a deficiency of the posterior superior angles of the parietal bone. Proceeding still farther back, we arrive at the occipital region, a space exceedingly circumscribed, being entirely formed of the upper part of the occipital bone, bounded above by the lambdoidal suture, and below by the superior semicircular line; it is smooth, convex, and covered by the occipito-frontalis, with the ramifications of the occipital artery, and great occipital nerve. The lateral regions are defined by a curved line, drawn from the external orbital process of the os frontis, backwards to the point where the superior semicircular line on the occipital bone strikes the mastoid process of the temporal bone; this would form its superior boundary, while its inferior is constituted by the zygomatic arch with its horizontal root, as far back as the lambdoid suture, and mastoid process. According to this definition we would find the lateral regions to be semicircular in form, flattened anteriorly, and slightly convex posteriorly, and presenting for consideration the following parts:—most anteriorly the temporal fossa, bounded above by the temporal ridge, below by the horizontal root of the zygoma, and crest on the great wing of the sphenoid, which separates it from the zygomatic fossa; it is semilunar in shape, and formed by the following bones, from before backwards, viz.: malar, frontal, great wing of sphenoid, squamous plate of temporal, and parietal; it affords attachment to the temporal muscle, and by its upper curved margin to the strong temporal aponeurosis. Below, and slightly posterior to the temporal fossa, is the external auditory meatus, of an oval figure, bounded above by the horizontal root of the zygoma, behind by the mastoid, and in front and below by the auditory process; it forms the external orifice of the osseous tube of the organ of hearing, while immediately posterior to it, is the mastoid process, displaying all those peculiarities, and having connected to it those several parts that have been already enumerated in the description of the separate bone.

If we now direct our attention to the true base, we will find it to be exceedingly irregular on its surface, but rather quadrilateral in its outline; that part behind the foramen magnum presenting in the mesial line the occipital protuberance for the attachment of the liga-

mentum nuchæ, and the superior and inferior semicircular lines with the groove separating them; the muscles attached to them have been already mentioned. Passing still farther forwards, we arrive at the foramen magnum, oval in shape, and long antero-posteriorly, for the transmission of the medulla oblongata with its vessels, vertebral artery and spinal accessory nerve. On either side of it are the two condyles, likewise oval in shape, and very prominent, looking downwards, forwards, and outwards, marked internally by a small pit for the insertion of the cheek ligaments; perforated anteriorly and posteriorly by two foramina, those in front being large and round, for the passage of the ninth pair; those behind small, and occasionally absent, for the transmission of a minute vein from the vertebral to the lateral sinus; externally, the condyles become continuous with the jugular ridge, into which is inserted the rectus capitis lateralis; while external to this ridge is the small groove for the occipital artery, then a slight elevation for the insertion of the trachelo-mastoideus, external to which is the elongated fossa for the origin of the digastric, which is bounded on the outside by the tip of the mastoid process. Two foramina are situated anterior to the parts we have enumerated, one internal, large and ovoid in shape, called the posterior lacerated, formed between the temporal and occipital bones, bounded behind by the jugular ridge, in front by the carotid foramen, internally by the anterior condyloid hole, externally by the styloid and vaginal processes of the temporal bone; this hole is usually divided into three chambers by septa, sometimes bone, sometimes cartilage—the most posterior, the largest, giving passage to the internal jugular vein; the middle, intermediate in size, to the pneumo-gastric and spinal accessory nerves; and the most anterior to the glosso-pharyngeal; the second foramen, known as the stylo-mastoid, lies between the styloid process in front, the mastoid behind, and posterior lacerated internally, and gives exit to the facial nerve, the stylo-mastoid artery entering at the same time. Returning now to the mesial line, we find the cuneiform process of the occipital stretching upwards and forwards to join the body of the sphenoid; it is flattened but rough, broader behind than in front, giving attachment by its posterior border to the apparatus ligamentosus colli; more anteriorly to the two portions of the occipito-atlantoid ligament, to the recti capitis antici, minor and major, to the middle and superior constrictors; and is ultimately covered by the mucous membrane of the upper part of the mouth. This process of the occipital is bounded on either side by the petrous portion of the temporal bones; which divaricating posteriorly and converging anteriorly, terminate in front in a remarkable foramen called the anterior lacerated, formed by the union of the sphenoid, occipital and temporal; in the natural

condition of the parts this hole is filled up by cartilage, to which is attached inferiorly the Eustachian tube; superiorly the carotid artery grooves it, while it is likewise perforated by the Vidian nerve, the canal for which opens on it anteriorly and inferiorly. Behind this hole, the bone presents a broad, rough expansion, for the origin of the levator palati and petro-pharyngeal aponeurosis, and still farther back is a rounded hole,—the carotid, for the entrance of the artery of the same name, and the branches of the sympathetic nerve,—the nervi molles which accompany it. The carotid foramen is bounded behind by the posterior lacerated hole; anteriorly and internally by the attachment of the petro-pharyngeal aponeurosis, externally and anteriorly by the Eustachian tube, directly anteriorly by the middle meningeal artery and internal lateral ligament of the lower jaw, and externally by the vaginal process of the temporal bone. On the outer side of the carotid foramen, is the glenoid cavity, oval in shape, concave, and covered with cartilage; bounded anteriorly by the transverse root of the zygoma, externally by its horizontal root and auditory process, posteriorly by the styloid and vaginal processes of the temporal bone, and internally by the spinous and styloid of the sphenoid, by the internal lateral ligament, and middle meningeal artery; traversing it from without, forwards and inwards, we have the Glaserian fissure, for the passage of the parts already enumerated in the description of the separate bone, and for the attachment of the capsular ligament. Between the outer edge of the petrous portion of the temporal bone and great wing of the sphenoid is a groove, directed upwards, backwards, and outwards, which terminates in an osseous canal, about three-quarters of an inch in length, forming the bony portion of the Eustachian tube.

From this point, as we have already premised, it will be necessary for us to consider the remainder of the external part of the cranium in connexion with the face, for the two are so completely blended with each other in the formation of the several fossæ, regions and cavities, that to separate them would be only to render a subject already intricate, still more complicated. We shall therefore be content to observe, that the face, taken as a whole, is of a triangular shape with its base superiorly; its greatest vertical measurement being from above downwards, between the nasal spine of the frontal bone and the lowest part of the symphysis menti; and its greatest transverse, between the prominences of the malar bones. Its lower or guttural surface would be mapped out by a line extending backwards from the lower part of symphysis, in the direction of the foramen magnum; it is extremely irregular in its outline, as we shall presently observe; while the upper portion becomes completely blended with the lower and anterior part of the cranium.

The zygomatic fossa, common both to the head and face, is quadrilateral in figure, and concave; bounded externally by the crest on the great wing of the sphenoid, internally by the external pterygoid plate, anteriorly by the tuber maxillare, and behind by the transverse root of the zygoma; towards its outer part, it is crossed from before backwards by the external pterygoid muscle; posteriorly and internally is the small spinous hole for the artery of the same name, lying between the spinous and styloid processes of the sphenoid, and having internal to it, the groove for the Eustachian tube; while anterior and a little internal to this hole is the foramen ovale, for the transmission of the inferior maxillary nerve, and the anterior meningeal from the pharyngea ascendens. The foramen ovale is bounded anteriorly by the origin of the internal pterygoid muscle; posteriorly by the spinous and styloid processes of the sphenoid, internal lateral ligament and middle meningeal artery; internally by the Eustachian tube; and externally by the external pterygoid muscle. As we pass still further forwards, we arrive at a remarkable cleft, broad above and narrow below, opening into the pterygo-maxillary fossa; this fossa is bounded in front by the tuber maxillare, behind by the pterygoid plates, above by the great wing of the sphenoid, below by the junction of the superior maxillary, palate, and pterygoid plates, and internally by the nasal plate of the palate bone; while externally it is free, and opens into the zygomatic fossa. This bony recess is deep, and contains the superior maxillary nerve, Meckel's ganglion, and the terminal stage of the internal maxillary artery; but to accommodate the several parts which enter and leave it, we will find that several foramina are found communicating with it; thus in its roof or upper part, is the foramen rotundum, through which the superior maxillary nerve enters; from its floor or lower part the posterior palatine canal, formed by the tuber maxillare, nasal plate of the palate, and pterygoid processes, stretches downwards, for the transmission of the posterior palatine nerve from Meckel's ganglion, and posterior palatine artery; its inner wall is perforated by the spheno-palatine hole, for the nerve of the same name, and that from the same ganglion to enter the superior meatus of the nose; this small foramen being bounded by the orbital process of the palate anteriorly, its nasal plate inferiorly, its sphenoidal process posteriorly, and above by the body of the sphenoid; from the posterior wall of the fossa the Vidian canal commences, and passes backwards and outwards, to terminate in the anterior lacerated foramen; while from its anterior wall springs the infra-orbital canal, which opens immediately beneath the orbit, carrying the infra-orbital nerve and artery for the supply of the face.

We conceive it better to defer the consideration of the posterior

nares for the present, as they will be discussed more legitimately with the nose, of which they form an integral part, and will therefore pass on to the hard palate which comes next in order, and which belongs essentially to the face. The hard palate lies the most inferior of all those spaces as yet described and is parabolic in shape, with the curved convexity directed forwards, bounded anteriorly and laterally by the alveolar arches, and posteriorly by the free margins of the palate bones, which here present a double lunated edge, with the spine in the mesial line giving attachment to the velum pendulum palati and azygos uvulæ. This region, always more or less concave in all individuals, but very variable as to its degree, is extremely rough for the attachment of the mucous membrane, and presents in the middle line, at the junction of its posterior with its two anterior thirds, a crucial ridge formed by the decussation of the sutures between the palates and superior maxillaries; that between the latter, however, being incomplete anteriorly from the existence of the incisive fissure; towards its posterior and external angles we observe two foramina, the anterior large, being the external orifice of the posterior palatine canal, and the posterior much smaller, called its accessory, transmitting a small nerve for the supply of the soft palate. Leading from the larger orifice and taking a direction forwards and inwards, immediately internal to the alveolar arch, is a deep groove, which lodges the anterior branch of the posterior palatine nerve in its course to the foramen incisivum, where it forms by its anastomosis with the naso-palatine, or nerve of Cotunnius, the ganglion of Cloquet.

We will now direct our attention to the anterior part of the face, which we have already described as being triangular in form, with the base above at the malar bones, and the apex below formed by the prominence of the symphysis menti; on either side of which and directly below the alveolar process are the myrtiform fossæ, which have been already considered in the detached bone. Similar depressions exist also above the incisors of the superior maxilla, which, with the canine fossæ, have been likewise alluded to in the general examination of the separate bones, so that we may, therefore, at once proceed to the examination of those great cavities which the face presents, viz., the nasal, and orbital, commencing with the former.

Looking at the anterior surface of the nose, as viewed on the dry skull, it is found to be heart-shaped, the broader part turned downwards and backwards, but contracted and slightly rounded above. The greater part of its margin, is formed by the two superior maxillary bones, which bound it inferiorly and laterally, while the two nasal bones which complete it above, constitute a very limited portion of it. The cavity of the nose, however, taken as a whole, may be

said to be conical, with a vaulted roof above, and a floor below, the entire being divided into two lesser chambers, called the nares by a vertical partition termed the septum narium. On either side it is bounded by an external wall sloping gently downwards and outwards, which is formed by the apposition of six bones, these, taken from before backwards, being the nasal process of the superior maxillary, behind which is the lachrymal; still farther back, the os planum of the ethmoid, below which is the inferior spongy; more posteriorly still is the nasal plate of the palate, and behind this again the internal pterygoid plate; the floor, which is inclined slightly downwards and backwards, and concave from side to side, is composed of two bones only, or rather parts of them; these being the nasal plates of the superior maxillary and palate; looking now to the roof, which is vaulted or crescentic, we find it to consist of five bones, viz., the two nasal, and frontal, which look downwards and backwards, the cribriform plate of the ethmoid, which looks nearly vertically downwards, and the body of the sphenoid, the aspect of which is downwards and forwards; five bones contribute to form the septum, viz., the vomer, nasal lamella of the ethmoid, azygos process of the sphenoid, with the crests of the palate and superior maxillary. Each of those nares are again subdivided into a series of minor cavities, three in number, called meatuses, intercepted between the three spongy bones; thus the superior meatus, the shortest of the three, occupies a position between the superior and middle spongy bone; the middle, the most curved, between the middle and inferior; and the inferior, the largest, between the inferior spongy bone and floor of the nose. As a general rule it may be stated that all those meatuses are inclined more or less downwards and backwards, and hence it follows that the inferior must receive the secretion from the other two, previous to its being expelled from the anterior orifice of the cavity, or to its being swallowed with the saliva, as it trickles down to the back part of the pharynx. On looking into the posterior nares these meatuses are very apparent, and a good idea can thus be obtained of the curled appearance presented by the spongy bones as they lie one above the other, with their convexities directed towards the septum, from which they are distant generally two or three lines, but occasionally are in close contact with it. Anteriorly, as already remarked, the several meatuses have no communication with each other, but posteriorly their extremities are free, and through the patulous intervals at this point they freely communicate with each other, and with the cavity of the pharynx. The superior meatus receives the openings of the sphenoidal sinus, the posterior ethmoidal cells, and spheno-palatine hole, the orifice of the first of these being usually single, but the cells of the ethmoid

have distinct apertures, generally very small and about five or six in number, while the spheno-palatine hole is found near its superior and posterior part, opening from the pterygo-maxillary fossa; but from the manner in which the mucous membrane is reflected over it in its natural state the aperture is not very apparent on its nasal surface; it, however, transmits the spheno-palatine branches of the internal maxillary, and the nerve of the same name, from Meckel's ganglion, for the supply of the mucous membrane of the cavity. Into the middle meatus, which we have already stated is very curved in its figure, the frontal sinus, anterior ethmoidal cells, and foramen antri, open; the first of these or the frontal sinus, curves downwards and backwards, to terminate in a kind of tube called the infundibulum, composed partly of bone and partly of the Schneiderian membrane, presenting a slight dilatation at its nasal extremity, which can be seen properly only on raising upwards the middle spongy bone. By this means we also bring into view the small orifices of the ethmoidal cells, some of them opening directly into the meatus, and others into the infundibulum, while a little below this last-named process, the fissure of the antrum is also visible. This latter hole, so very large in the superior maxillary, if examined in its dry condition, is extremely circumscribed in its natural state, so as scarcely to admit the introduction of the blunt end of a probe, and this is owing to the manner in which its orifice is encroached on, by the lax mucous membrane in its vicinity, as well as by the other bones that are contiguous to it. Thus the lachrymal overlaps it in front, the nasal plate of the palate behind, the os planum of the ethmoid above, and the inferior spongy below. If we now proceed to the inferior meatus, we will find that the anterior palatine canal in front, the nasal duct in the middle, and the Eustachian tube behind, severally open into it. With respect to the first or anterior palatine canal, it cannot be said properly to open into the cavity of the inferior meatus, as the mucous membrane is reflected over it, and thus occludes it; but as it is apparent on the dry bone, we have considered it proper to be mentioned, more especially as it is the canal through which the nerve of Cotunnius passes to reach the incisive fossa, to assist in forming the ganglion of Cloquet. The nasal duct, the orifice of which is situated a little posterior to the anterior extremity of the inferior spongy bone, and about three-quarters of an inch from the anterior nares, is the canal through which the tears are transmitted from the inner canthus of the eye to the nose, and is, in fact, nothing more than the continuation downwards of the lachrymal sac. It is about three-quarters of an inch in length, and slightly curved, with the convexity turned forwards and inwards, its direction being at first downwards and forwards, and then backwards and outwards;

the bones that enter into its formation are three, viz., the nasal process of the superior maxillary, the os unguis, and inferior turbinated bone, the canal which is left between them being capable of admitting a large probe. At the posterior extremity of the inferior spongy bone, and lying against the inner side of the internal pterygoid plate, the nasal extremity of the Eustachian tube is observed, but as this will be more properly examined in another place we will defer its consideration for the present.

Anatomists have conferred the title of the Schneiderian membrane on the mucous lining of the nose, from the name of the individual who first distinctly described it. In front, it is directly continuous with the skin of the face; and behind, no absolute line of division can be drawn between it, and what is found lining the inside of the pharynx. Extremely thin, and firmly adherent to the bony structures of the canals and sinuses which it covers, it becomes, in fact, incorporated with the periosteum, and hence its name of fibro-mucous; but on the septum and spongy bones, particularly towards their posterior parts, its character is completely changed, becoming in those situations dense and thick, this increase of development being due, in a great measure, to the numerous vascular plexuses, especially venous, which are found in this part, as well as to a multitude of glands which here exist in vast numbers. In its external characters, likewise, the mucous membrane differs in the several parts of the cavity in which it may be examined; in front, exhibiting a scaly appearance very similar to that of the skin, with which it is continuous; whilst behind, and in the sinuses, we find it changing to the columnar variety, and ciliated. This epithelium is exceedingly minute in the cells, while above and behind it is scarcely visible, not well defined, and presenting a darker hue from the pigment with which it is covered, and which is here very freely deposited. In the anterior part we likewise observe it to be studded with hairs, termed vibrissæ, which are fine and short in the young, but which increase both in length and thickness with advancing years. The mucous membrane exercises a peculiar influence over the appearance of the several cavities of the nose, in rounding off its prominent edges, and in partially closing, in some instances, and in others obliterating altogether, the several foramina and sinuses. In tracing it round its circumference we might commence at any point, for instance the septum, down which it is continued as far as the floor, over which it sweeps and covers in the anterior palatine hole; a little farther back, it meets with the inferior orifice of the nasal duct, around the edges of which it forms a loose fold, and from which it is continued upwards through the canal to the lachrymal sac, to its ducts, and then through the puncta to become continuous with the conjunctiva;

while more posteriorly it meets with the Eustachian tube, and after forming another fold round its lips, is prolonged within it as far as the tympanum, which it lines, as well as the mastoid cells. Ascending now along the outer wall of the inferior meatus to its summit, it is again reflected downwards on the concave or outer suface of the inferior turbinated bone to its lower edge, where it forms a pendulous fold and then again ascends on its convex or inner surface, when, reaching the middle meatus, it passes up through the infundibulum into the frontal sinuses, which it lines, sends prolongations into the anterior ethmoidal cells, and folds around the orifice of the foramen antri, which it afterwards enters to spread out on the walls of that cavity, where it is remarkable for its tenuity. Having lined the middle meatus on both walls, we again find it forming its fold on the free edge of the middle turbinated bone, and it then ascends on its convex surface into the superior meatus; here it is tensely stretched across the spheno-palatine hole, and passes into the posterior ethmoidal cells and sphenoidal sinus, converting the latter into a funnel-shaped chamber; then, after covering in the whole of the superior meatus, it descends to the inferior border of the superior spongy bone, where, forming a very small fold, it is inflected upwards to the roof of the nose, which it crosses inwards to the septum, or to that point from which we at first started.

In order to complete the nasal cavity, it will be now necessary to take a view of its flexible portion, or that formed by the cartilages, which are five in number,—one median or septal, and two lateral,—the superior or nasal, and the inferior or alar. Of these the septal cartilage is of an irregular quadrilateral figure, presenting two surfaces, corresponding to either nostril, and covered with mucous membrane, which is here extremely thick and studded with hairs; and four margins, of which the anterior stretches upwards and slightly backwards, and is received between the lateral cartilages and the slight groove between the nasal bones,—its posterior superior, directed backwards and downwards, unites with the nasal lamella of the ethmoid, its inferior posterior is received into a slit of the vomer, which is here fissured for its reception, while inferiorly it is attached to the symphysis of the two superior maxillary bones for a very short distance posteriorly, but is free for the greatest part of its extent anteriorly, where it is united by fibrous tissue to the broad and rounded columella, which forms the line of division between the nares of opposite sides. At the retreating angle of junction above and behind, between the nasal lamella of the ethmoid and vomer, a caudate prolongation from this cartilage is sent upwards and backwards between these bones, to be attached to the azygos process of the sphenoid; it resembles a narrow band, thin

and irregular above, but smooth and rounded below. The nasal cartilages, situated superiorly, are of a semilunar shape, thick anteriorly, where they are united to each other, forming the dorsum of the nose, and leaving a triangular groove between them for the reception of the septal cartilage; but united above to the nasal bones, on either side to the sharp edge of the nasal notch of the superior maxillary, and below to the altar or lateral cartilages; the mode of union at all those points being by white fibrous tissue, strong, but at the same time sufficiently lax to allow of a great amount of mobility. The alar or inferior cartilages, are very irregular in shape, and may be said to consist of a body with two caudate processes. The body is of an oval shape when viewed on its external aspect, but on examining it more carefully it will be found that a thin plate curves backwards and inwards, those of the opposite sides being in contact with each other inferiorly, with the intervention of some loose areolar tissue, and occasionally a cartilaginous nodule to facilitate motion, constituting the lobe of the nose; but above they are apart, where the septum fits in between them, and is attached to them by fibrous membrane. Their upper edge is connected with the nasal cartilage, but only for a limited extent, their inferior margin being deeply scolloped to increase the size of the nostril, while of their caudate extremities one is prolonged around the edge of the orifice, in the form of sesamoid tubercles, to be ultimately attached to the nasal spine of the superior maxillary, and the other, descending in the mesial line to the same point, becomes thick and rounded, forming the columella nasi, around the whole being reflected the dense integument, which constitutes in fact the principal part of the ala of the nose.

The vessels and nerves, for the supply of the organ of smell, are derived from different sources, the arterial being received principally from the internal maxillary in its third stage, as it lies in the pterygo-maxillary fossa. Its branches enter the nose through the spheno-palatine foramina, and, breaking up into numerous filaments, form plexuses with the artery of the septum from the superior coronary, with the anterior and posterior ethmoidal from the ophthalmic, as well as with twigs from the posterior palatine, and small perforating offsets from the lateral nasal of the facial: their *effête* blood being again taken up by a series of veins, which likewise anastomose freely, and form plexuses much larger than the arterial, to be ultimately removed by two trunks,—a superior, which runs along the convex border of the nose; and an inferior, along the lower edge of the lateral cartilage; both uniting on the outside of the ala, and, stretching obliquely upwards, to join the angular, the spheno-palatine likewise

aiding in its removal. The vein, thus formed, opens into the great alveolar plexus, which again terminates in the facial.

The nerves which supply the nose are also numerous, the principal being the olfactory, which stands pre-eminent above the others from the function over which it presides, viz., the sense of smell. At present, we have merely to direct our attention to its termination, to the exclusion altogether of its remarkable origin, and of the other peculiarities which it exhibits in its course from the brain to the cribriform plate of the ethmoid, where it expands into its bulb; and accordingly we find, that from the inferior surface of the latter it throws off from twenty to twenty-five filaments, which enter the cavity of the nose through the small foramina of the perforated plate, each invested with its proper sheath, borrowed from the dura mater. They are divided into three sets,—an external, middle, and internal, and descend between the mucous membrane and the bony structure, at first forming plexuses, but afterwards pursuing their course in separate filaments, to be lost in the mucous lining, into which they can be distinctly traced; the external stretching down as far as the middle spongy bone; the middle covering the roof; and the internal extending nearly as far as a horizontal line drawn through the centre of the septum. Some anatomists assert, that they anastomose freely with the spheno-palatine and proper nasal; but this assertion still requires corroboration.

The spheno-palatine nerve, a branch from Meckel's ganglion, enters the nose through the foramen of the same name from the pterygo-maxillary fossa, and divides into numerous branches, which ramify on the surfaces of the septum, and spongy bones. Of these, one filament has been invested with great importance from the anatomist who first described it,—the nerve of Cotunnius, or naso-palatine, which passes downwards and forwards, along the caudate appendage of the septal cartilage, generally overlapped by the edge of the vomer till it reaches the incisive fossa, where it unites with the posterior palatine to form Cloquet's ganglion. Pathology and actual experiment, have taught us that all those branches preside over common sensation, and secretion.

The proper nasal, a branch of the ophthalmic division of the fifth, leaves the orbit through the anterior ethmoidal hole, and entering the cavity of the cranium, crosses the cribriform plate of the ethmoid anterior to the olfactory filaments; it now descends through a slit at the side of crista galli, and reaching the roof of the nose, divides into two branches,—a posterior, which passing downwards and backwards on the septum which it supplies, anastomoses with the spheno-palatine; and an anterior, which passing downwards and forwards, grooves

the nasal bones, and then passes out between them and the nasal cartilages, to be distributed to the tip or lobe of the nose. This nerve connects in some measure the nose and orbit together, as irritation of it causes copious lachrymation, evidently for the purpose of clearing the nasal cavities of any offending body that may accidentally lodge within them.

The last cavities which we will have to describe are the orbits, those bony cases which contain the organ of vision, with all its muscular and nervous provisions. They are two in number, placed immediately below the cranium and above the face, are conical in shape, with the base turned forwards and outwards, and the apex backwards and inwards; their long axis being such, that two probes made to traverse them from before backwards, and carried through the optic hole into the cavity of the cranium, would decussate nearly at the sella turcica. The rim or edge of the orbit, quadrilateral in figure, but with the angles rounded off, is composed of three bones, viz., the frontal above, the malar externally and inferiorly, and the superior maxillary inferiorly and internally; while it has four walls,—a superior or roof, an inferior or floor, and an external and internal side, all of which terminate in a point, and meet posteriorly at the ridge of bone between the lacerated and optic holes. The superior wall or roof, concave, and consisting of two bones, the frontal and lesser wing of the sphenoid, looks downwards and forwards, presenting externally and anteriorly, a depression for the reception of the lachrymal gland; and internally and anteriorly a small process of bone for the tendon of the superior oblique to play through; the inferior wall, flat and smooth, looks upwards, forwards, and outwards, and is formed by three bones, viz., the malar anteriorly, the superior maxillary in the middle, and the small process of the palate bone posteriorly; the superior maxillary at its junction internally with the malar bone giving origin to the inferior oblique muscle, and near its centre being generally more or less fissured for the infra-orbital canal. The internal wall, slightly concave, is composed of three bones,—the os unguis anteriorly, the os planum of the ethmoid in the centre, and the side of the body of the sphenoid posteriorly; it looks directly outwards, while in the external wall are two bones only,—the malar in front, and the great wing of the sphenoid behind; its aspect being forwards and inwards. Contrasting now the several lengths of the four walls, we will find that they present the following differences: while the superior is the longest, and the external the shortest, the slight differences which exist between the internal, and inferior preponderate rather in favour of the latter; the deep excavated groove observed in the rim of the external wall is evidently placed there for the purpose of extending the range of vision in that direction, a

similar arrangement not being required internally, as the eye of the opposite side can fulfil what would be deficient in the range of its fellow.

Proceeding now to the examination of the several foramina which are found in the orbit, the most important from its functions, would appear to be the optic. This is a large hole, long transversely on its cranial aspect, but from above downwards on its orbital, directed downwards, forwards, and outwards, and situated in the side of the body of the sphenoid, a little internal and superior to the apex of the cavity, and having two very important parts passing through it, viz., the optic nerve, and the ophthalmic artery. Lying on a plane external and inferior to it, is the sphenoidal fissure, or foramen lacerum orbitale, irregularly triangular in shape, with the base turned backwards, inwards and downwards; and the apex upwards, forwards, and outwards; bounded by the lesser wing of the sphenoid above, by the greater below, by the body internally, and by the junction of the two wings with the frontal externally. The following parts pass through it, in order from above downwards:—first, the fourth; second, the frontal; third, the superior division of the third; fourth, the lachrymal; fifth, the nasal; sixth, the inferior division of the third; seventh, the sixth; eighth, the ophthalmic vein, with a few branches of the sympathetic; ninth, lachrymal branch of middle meningeal externally; tenth, the dura mater, to form the periosteum of the orbit, and one head of the external rectus; the sphenoidal fissure also separates partially the superior from the external wall of the orbit. In the inferior and external part of the cavity, another remarkable fissure is observed, called the spheno-maxillary; it is hour-glass in shape, broad at either extremity, but contracted a little behind its centre; its direction being backwards and inwards, and having the following boundaries:—externally the great wing of the sphenoid; internally the orbital plate of the superior maxillary, and palate; and anteriorly the edge of the malar; while behind it communicates with the pterygo-maxillary fossa. It transmits small twigs from the internal maxillary artery, for the supply of the inferior muscles, with the orbital twig of the superior maxillary nerve, to anastomose with the lachrymal on the outer wall of the orbit, and from the arch of communication between them, two small twigs, the superficialis malæ, and temporo-malar, are given off, to be transmitted through two or three small foramina, which are visible, for their passage to the external parts. In the internal wall, but towards its posterior part, two small round holes are visible, apart from each other about a quarter of an inch; called the anterior, and posterior ethmoidal, because they are occasionally proper to that bone; the one transmitting a small artery, with the nasal twig of the ophthalmic, and

the other, a small artery only, while in the front part of the internal wall we may likewise observe the opening of the nasal duct, which has already been fully examined in the description of the nose. The upper wall presents only a single hole, sometimes a notch, just at its verge, for the supra-orbital artery, and nerve; while the lower can scarcely be said to be similarly circumstanced, as the infra-orbital hole is the termination of a canal which, properly speaking, is outside the cavity.

Having thus briefly endeavoured to consider the exterior of the skull, we must now proceed to take a slight review of its interior. This may be done by making a horizontal section a little above the superciliary arches, which being carried back to the occipital protuberance will give us two portions for examination,—a superior, constituting the vault; and an inferior, comprising the cerebral fossæ. The vault of the cranium, arched both antero-posteriorly and laterally, and formed on either side by the greater portions of the parietal bones, with a small part of the squamous plates of the temporal, behind by about one-third of the occipital, and in front by two-thirds of the frontal, presents in the mesial line from before backwards, anteriorly the frontal ridge, which as it proceeds backwards, bifurcates and becomes continuous more posteriorly with the parietal groove, and still farther back with the occipital ridge. Along this line the remains of the sutures are visible, but not to the same extent as on the outer surface of the skull, neither are they denticulated, but the openings of the emissary holes of Santorini may be clearly oberved near the posterior superior angle of the parietal bone, with the depressions for the glandulæ Pacchioni deeply indented along either side of the parietal suture. Anteriorly, are the frontal fossæ on each side, with the parietal posterior to them, and still farther back the occipital, all corresponding to the eminences on the outside, while the general surface on the inside is marked by irregular elevations and depressions, coinciding with the convolutions of the brain, and laterally by the shallow grooves for the lodgment of vessels in their sinuous course between the bone and dura mater. We may also remark the lines of suture between the frontal and parietal; between the latter and the temporal; and likewise, between the occipital and parietal, the ossa Wormiana being wedged in between the two last, making the suture on this account much more apparent than any of the others.

The lower part or floor of the cavity, more complex in its arrangement than the upper, comprises, as we have already stated, the cerebral fossæ, which do not lie on the same plane, but inclined like the steps of a stairs from above and in front, downwards and backwards, and are three in number, viz., the anterior, middle, and

posterior, and these we will examine, each in the order in which we have named them. The anterior fossa, of a semilunar shape, and bounded in front and on each side by the curve of the frontal bone; behind by an undulating line, the convexity of which is turned forwards, formed by the posterior margin of the lesser wings and anterior lip of the olivary groove, may be divided into three distinct portions,—a median, or ethmoidal; and two lateral, or spheno-frontal. Of these the ethmoidal, oblong and narrow from side to side, and depressed, presents anteriorly the foramen cœcum or canal of communication between the nose and great longitudinal sinus; behind it the crista galli, on each side of which are the slits for the transmission of the nasal twigs of the ophthalmic; more externally and posteriorly the double row of holes for the passage of the branches of the olfactory bulb, and at its verge the orifice for the entrance of the nasal nerve from the anterior ethmoidal foramen; more posteriorly the line of suture between the ethmoid and sphenoid, with a slight elevation in the centre corresponding to the spine of the latter, with a depression at each side, on which the olfactory nerves recline. The lateral portions, consisting of the frontal and lesser wing of the sphenoid, present a most irregular appearance, mammillary eminences and digital depressions being numerous and well-marked; and this is the more striking because the same part of the bones on their inferior aspect, where they form the roof of the orbit, are remarkable for their smoothness and regularity. The fossa just described supports the anterior lobe of the cerebrum. The middle fossa of the cranium lies on a plane, posterior and inferior to the last described,—bounded in front by the lesser wings of the sphenoid, and anterior lip of the olivary process; behind by the upper margins of the petrous portions of the temporal bones, and posterior clinoid processes; and externally by part of the great wing of the sphenoid, by the parietal, and squamous plate of temporal; while its floor, formed by the body and great wing of the sphenoid, and petrous portion of the temporal, is very concave. Like the preceding, however, it may be divided into a central or sphenoidal, and two lateral regions. Of these the central portion presents anteriorly the groove of the olivary process, terminating on either side in the optic foramina, for the passage of the optic nerve, and ophthalmic artery, behind which are the two anterior clinoid processes; still more posterior is the sella turcica, for the reception of the pituitary gland and circular sinus; this deep recess being bounded behind by the prominence of the posterior clinoid processes. The lateral regions are perforated anteriorly, by the sphenoidal fissure, for the transmission of the nerves into the orbit. Behind this, is a slight depression, corresponding to the cavernous sinus; more posteriorly, the opening of the anterior lacerated foramen; external, and a little

anterior to this, the foramen rotundum, for the passage of the superior maxillary nerve; more posteriorly, the foramen ovale for the exit of the inferior maxillary, and entrance of the small meningeal artery; still farther back, the spinous hole, for the artery of the same name; more posteriorly, the hiatus Fallopii for the entrance of the Vidian nerve, external and anterior to which is the small fissure for the exit of the nervus petrosus superficialis minor. In this fossa are contained the middle lobes of the cerebrum.

The posterior fossa, is situated on a still lower plane than the other two, and is equal to them both in capacity. It is deeply concave, and bounded in front by the superior edges of the petrous portions of the temporal bones and posterior clinoid processes, laterally and behind by the posterior inferior angles of the parietal bones, and the transverse ridges of the occipital, while the floor is formed by the occipital, parts of the sphenoid, and mastoid portion of the temporal. It likewise presents a median, and two lateral regions. The central region presents a grooved surface on the basilar portions of the occipital and sphenoid bones, for supporting the pons varolii, basilar artery, and sixth pair of nerves; and more posteriorly, the foramen magnum for the passage of the medulla oblongata, with the nerves and vessels accompanying it; on each side of which are the anterior, and posterior condyloid foramina, the one for the exit of the lingual nerve; and the other for a small vein which passes through it. The lateral regions comprehend the deep occipital fossæ for the reception of the lobes of the cerebellum, separated from each other by a well-marked vertical ridge, to which the falx cerebelli is attached; while towards their external side, they are grooved deeply for the lateral sinuses, which terminate into a large ovoid foramen, the posterior lacerated, for the transmission of the internal jugular vein and eighth pair of nerves; more superiorly is the internal auditory meatus, into which enter the seventh pair of nerves and the small auricular artery; behind which is the aqueduct of the vestibule, from which a small vein emerges.

SECTION II.

SYNDESMOLOGY, OR THE ANATOMY OF THE JOINTS.

A JOINT OF ARTICULATION in the human skeleton, is formed by two or more solid tissues (generally bones) meeting together and united by ligaments, such union resulting in mobility, as exemplified in the bones constituting the hip joint; or in absolute fixity, as in those

forming the sagittal, or coronal sutures in the cranium; it is termed complete when bone, cartilage, ligaments, and synovial membrane enter into its conformation, but incomplete when any one of these is absent. We will now proceed to examine the several structures here enumerated individually, commencing with the articular extremities of bones, which are found to be expanded laterally in hinge-joints, and circumferentially in the enarthrodial class, for the purpose of increasing their surfaces of apposition; but as this augmentation would necessarily produce an excess of weight inconsistent with rapidity of motion, if the extremity exhibited a structure dense, and compact similar to the shaft; to obviate this inconvenience, the volume of the articular extremity is composed principally of a light spongy tissue; an arrangement that would seem to incur a certain susceptibility to fracture, but which is, however, prevented first by the shock being equally diffused over a more extensive surface; and, secondly, by a thin layer of an elastic tissue (cartilage) being interposed between the opposed surfaces.

Cartilage, in connection with joints, is observed to present two varieties: the articular, or cartilage of incrustation, which covers and adheres to the articular extremities; and interarticular, which is placed in such situations that it tends to adapt varying convexities and concavities, as well as to diminish the intensity of those shocks to which the extremities are so constantly liable. These cartilages differ from each other in structure also, the articular being termed true; the interarticular, false or fibro-cartilage; the former consisting of an hyaline or structureless basis, containing numerous cells with indistinct walls and compound nuclei, with oily particles,—these cells having a linear arrangement, vertical to the surface in the articular cartilages; but in the laryngeal, tracheal, costal, nasal, and auricular cartilages, although all belonging to the same system, they are without any definite arrangement: whilst the false or fibro-cartilages are composed of wavy bands of fibrous tissue, containing in their areolæ but few cells, and these devoid of that bold outline that characterizes the true. The fibro-cartilages are principally interarticular; but this tissue also lines those osseous grooves, through or over which, tendons play, and is termed stratiform cartilage when in those positions. Again, true cartilage yields an animal matter, when subjected to long boiling, called chondrine, a substance nearly allied to gelatine, but it differs from the latter in not being precipitated by tannic acid from a solution; and in being thrown down by acetic acid, acetate of lead, and protosulphate of iron. The cartilage of bone before ossification (true) yields chondrine only; but at the completion of that process, gelatine is the product obtained; while fibro-cartilage yields gelatine without a trace of chondrine. Articular

cartilage is always thicker on the centre of a convexity; the opposite rule prevailing in reference to concavities; but its connexion to the bone is not exactly determined; four means of conjunction having been enumerated: firstly, by mutually irregular but indigitating surfaces; secondly, by vascular loops; thirdly, by a continuation of the synovial membrane over its surface; and, fourthly, by a prolongation of the periosteum between it and the bone. The vessels terminate at the margins in loops, which are frequently dilated into ampullæ—not, at least in the adult, reaching the deep surface of the cartilage, as a thin layer of dense but porous bone intervenes; but in fœtal life canals exist, by which the blood plasma permeates the tissue for its nutrition; a vascular plexus also occurring at that period on the synovial surface, which disappears soon after birth. The fibro-cartilages are supplied by a circumferential vascular circle, from which loops are continued into the structure, but which always terminate before they reach the centre, or the point that is most liable to pressure.

Ligaments.—These belong to the class of fibrous tissues; in many, indeed in the majority, of situations being completely devoid of elasticity; as it is in a few only that that physical property is the predominant character, and hence we have white fibrous tissue constituting the former, and yellow elastic, the latter. The white, or non-elastic, is found in the human body expanded, so as to control and preserve the position of the muscles, (fasciæ); surrounding bones (as the periosteum, and dura mater), giving insertion to muscles (as tendons and aponeuroses), confining and protecting organs (pericardium, sclerotic, and tunica albuginea), or uniting bones, as ligaments. This tissue consists of wavy bands, that may pass parallel, or interlace, presenting faint longitudinal striæ, more indicative of simple creasing than divisibility. Under the action of acetic acid it becomes transparent, and yields gelatine on boiling; while its vascular supply is limited, and nervous organization probably absent. It is opaque, dense, resisting, inelastic, and extremely slow to take on inflammation; but on the supervention of that process, if acute, it rapidly sloughs; on the other hand, if the subject of chronic inflammatory action, it becomes vascular, and thickened by interstitial deposit, as in false nodes and diseases of the joints, thus producing false anchylosis.

Yellow elastic tissue is composed of fibres smaller than the last, branched and uniting with neighbouring filaments, and with a disposition to become curled when ruptured, while acetic acid does not produce transparency, but discloses the existence of nuclei. This tissue occurs in the ligamenta subflava, thyro-hyoid, crico-thyroid, stylo-hyoid, and calcaneo-scaphoid ligaments, as well as in the mid-

dle coat of the arterial tubes. A second form of elastic tissue is also found in those situations where a certain degree of contractility is required, as in the skin, nipple, dartos, crus penis, and smaller blood-vessels, while it is characterized by the presence of nuclei at regular intervals, and is the principal constituent of the vascular coats in the erectile tissues (Hassall). The ligaments of the human body have been divided into three forms, viz., the funicular, capsular, and the fasciculated, or membranous; the first occurring in connexion with ginglymoid joints; the second in the ball and socket; and the third are common to both.

Synovial membranes form a sub-class of serous tissues, are thin, semi-transparent, and constitute shut sacs. The external surface is rough, cellular, and attached, while the internal is smooth, free, and lubricated by a glairy fluid, termed synovia. Structurally it consists of a superficial covering of squamous epithelium, beneath which is a basement membrane, and most externally areolar tissue; in fœtal life the epithelium is capable of being traced over the surface of the cartilage, but this cannot be done in the adult. In several joints there occur certain fringed processes, and fatty bodies, described by Clopton Havers as special glands for the secretion of the synovia, but this fluid is unquestionably secreted by the entire free surface.

The Classifications of joints are numerous, as for example that depending on the mode of union, as syndesmosis, or synneurosis, where they are united by ligament; synchondrosis, where cartilage is the bond of union; meningosis, where they are connected by membrane, as in the fœtal cranial bones; and syssarcosis, where they are attached by muscle, as between the scapula, and ribs. A second classification depends on the motions enjoyed by the bones, as for instance that of Bichat, but this being in a great measure physiological, we will only briefly allude to it. The motions recognised are four only, namely, gliding, rotation, circumduction, and motions of opposition, but these he again sub-divided into joints with every motion perfect, as for example the hip and shoulder joints; secondly, into those with all motions save rotation, as the metacarpo-phalangeal articulation of the thumb and wrist joint; thirdly, joints only capable of the motion of apposition, as the elbow, and phalanges of fingers; fourthly, joints only admitting a rotatory movement, as the odontoid process of the axis with the atlas; and lastly, joints which glide on each other without any other especial motion, as in the tarsus, and carpus.

The division, with some variation, however, now in use in this country is that of Galen, who divided joints into two great classes; the movable, to which he gave the name of diarthrosis; and the

immovable, which he termed synarthrosis; to these Winslow has added a third, the mixed class, or amphiarthrosis.

Diarthrosis is subdivided into enarthrosis, arthrosis, ginglymus, and planiform arthrosis. These we shall now proceed to examine according to the order here specified.

Enarthrosis, is where a convexity unites with a corresponding concavity, the latter, however, embracing at least two-thirds of the former, forming, in fact, a ball and socket, the best example of which is found in the ilio-femoral articulation.

Arthrosis, on the other hand, is where there is either a shallow concavity and a slight convexity; or, where a marked disparity occurs between the opposing surfaces, as in the shoulder; where strength is sacrificed to secure rapidity and freedom of motion. This form of articulation has been divided into two classes,—the one single, being exemplified by the shoulder-joint; the other double, such as we find in the articular processes of the vertebræ, and temporo-maxillary articulation, where two distinct articulations are found on the same bone. This, by some, has been called condylarthrosis.

Planiform arthrosis, is where plane surfaces are opposed, as in the junction of the metarcarpal, and metatarsal bones with the carpal and tarsal; or the tarsal and carpal with each other; the motion permitted between them being very slight, and that of a gliding nature.

Ginglymus, or hinge joint, must also be divided into two kinds,—the one angular, and the other lateral; the former, or angular, having only the powers of flexion and extension, and being called complete where those motions only exist, as in the humero-cubital and phalangeal articulations, but incomplete where the slightest lateral or rotatory movement prevails, as in the knee and ankle joints. Lateral ginglymus is where two bones, lying side by side, articulate by their extremities, as in the instance of the radius and ulna, this being called double; but where, as in the case of the atlas and odontoid process of the axis, the latter unites with the former by its side, and that only at one point—this is termed single lateral ginglymus. This last articulation has likewise received the name of trochoides, hook and eye, or pivot and ring joint.

Synarthrosis, or the immovable class, is divided into the following:—Suture, harmonia, gomphosis, and schindylesis. With respect to sutures, they may be serrated, as the sagittal; denticulated, or dove-tailed, as the lambdoidal; and squamous, as in the temporal bone; while the palate plates of the superior maxillary bones are good examples of harmonia. Schindylesis occurs between the vomer, and rostrum of the sphenoid, where the former is deeply cleft to receive the latter; it also may be seen between the nasal lamella of the ethmoid and the vomer; and again between the last-named

and the two superior maxillæ, where the inferior edge of the first is received between the two latter. The connexion of the teeth with the alveoli affords instances of gomphosis; while immovable symphysis, which many regard as belonging to the synarthrodial class, is fully illustrated in the case of the symphysis menti.

Amphiarthroses, or mixed articulations, have been divided into the following:—Syndesmosis, synchondrosis, syssarcosis, symphysis, and synneurosis. Of these, syndesmosis, as its name implies, is simply union by ligament, where the bones so united are not in direct contact with each other, as in the axis and occipital bone, where the apparatus ligamentosus colli, and check ligaments are the bond of connexion; synchondrosis is union by cartilage, as between the sacrum and ilium, or between the vertebræ; syssarcosis, union by muscle, as between the scapulæ, and trunk, or os hyoides, and chin; symphysis, as between the two pubes; and synneurosis, as the patella, between the tendon of the rectus and ligamentum patellæ.

LIGAMENTS OF THE SPINE.

The structures which unite the spinal column may be divided into those which bind together the bodies, consisting of the intervertebral substance, and an anterior aud posterior common, or vaginal ligament; aud those which connect the processes, comprising the interspinous and supraspinous, the intertransverse, imperfect capsular, and ligamenta subflava. These we now propose to examine in order.

When describing the vertebræ, we stated that their bodies did not lie in contact with each other, but were separated by a greater or lesser interval, according to the region which they contributed to form, being most apart in the lumbar, and least in the cervical, the exception to this rule being the articulation of the atlas and axis, which lie in direct contact with each other. The interval alluded to is filled up by a substance described by some anatomists as fibro-cartilaginous, but by others said to be simply fibrous: it is called the intervertebral disc, and is in shape oval, but slightly flattened posteriorly, with its lateral measurement somewhat exceeding its antero-posterior, while its surfaces, both superior and inferior, are convex, corresponding to the partial cavities existing on the upper and under parts of the bodies of the bone, to which they are united by fibrous prolongations implanted into the osseous structure, and this with such a degree of tenacity, that we can with greater facility fracture the body of the bone, than rupture its attachment to the disc. If we call in the aid of maceration in order to examine its more intimate structure, we will find that the arrangement of its

fibres is not truly concentric, but decussating, crossing from the vertebra above to the vertebra below, at a very oblique angle, thus presenting a strong barrier to over-rotation. The circumferential portion of the disc is dense and compact, and has attached to it, before and behind, the anterior and posterior common ligaments, forming a kind of capsule for it; but at a point a little posterior to its centre a gradual change may be observed taking place in its appearance, the fibres insensibly becoming more apart, until they are at last completely lost in a pulpy substance, white, and extremely elastic in youth, but yellow and brittle in old age. If a knife be passed in through the middle of the disc in front, so as to pierce its anterior two-thirds, and then be withdrawn, this soft pulpy matter can be made to exude through the fissure by pressing the bodies of the adjacent bones forcibly together.

The intervertebral disc must be regarded not only as a powerful medium of connexion between the adjacent bones, but also as of vast importance in breaking shocks transmitted from below to the vertebral column. It is likewise of use in bestowing facility of motion, and in imparting elasticity and suppleness to this fundamental portion of the human skeleton.

The best method, and indeed the only true one, of examining the peculiarities which the disc presents in the several regions of the spine, is by making a vertical section in the antero-posterior direction, from the second vertebra to the second bone of the sacrum, when, on directing our attention to the cut surfaces thus brought into view, we will observe its greater thickness in the lumbar region, its wedge-like form, with the base turned anteriorly, especially conspicuous between the last vertebra and first bone of the sacrum, where its posterior margin is fined off to a striking degree of tenuity. In the dorsal region, on the contrary, there is a sensible decrease in the vertical height of this substance, the base of the wedge being now directed backwards, while in the cervical again the gradual diminution in depth still continues, but it follows the arrangement observable in the lumbar, in being deeper before than behind. Thus the alternating changes in the position of these wedge-like discs, are in a great measure the cause of the normal curvatures which are observed in the spine; the abnormal ones likewise depending in some degree upon their irregular development.

The Anterior Vaginal, or Common Ligament, situated on the front of the vertebral column, and extending from the body of the second cervical vertebra to the upper part of the first bone of the sacrum, is of a pearly-white colour, and consists of three distinct bands,—a median, and two lateral, separated from each other by imperfect intervals, through which the vessels pass in their

course to the bone. Maceration proves that it forms two, sometimes three, distinct planes of fibres, the deeper set being attached to the lips of two contiguous vertebræ, and an intervening intervertebral disc, while the more superficial extends over three, four, or five; their connexion, however, to the bodies of the bone is very slight, so much so that the handle of the scalpel can be sometimes passed between them and the ligament with great facility, but it is far otherwise with respect to its attachment to the margins and the disc, which is indeed most intimate in its character. In the lumbar region, the ligament is broadest; in the dorsal, densest; and in the cervical, much the weakest; but in the last, it is strengthened by the aponeurotic expansions of the longi colli, which in a great measure conceal it from view; in the dorsal, it has no adventitious support, but lies completely bare, forming the floor for the support of the parts contained in the posterior mediastinum, whilst in the lumbar, it is overlapped and supported by the tendinous origins of the crura of the diaphragm, and of the psoæ muscles.

The Posterior Common, or Vaginal Ligament, situated within the spinal canal, can therefore only be examined by separating the processes from the bodies of the bone through their entire extent, and when thus exposed it is found to present a great similarity to the anterior, but in structure it is much more dense and compact; like it, it stretches from the second cervical vertebra, where it appears to be a continuation of the apparatus ligamentosus colli, presently to be described, to the first bone of the sacrum, its margins exhibiting a peculiar scolloped appearance, depending on the manner in which processes are prolonged on the intervertebral substance, even through the foramina of conjugation, to be continuous with the anterior vaginal in front; its connexion to the back part of the bone is very slight, being confined to the upper and lower lip only, as the transverse venous sinuses, receiving the blood from the diploe, pass between and separate them, but it is completely incorporated with the posterior edge of the disc. In the dorsal region it is extremely narrow, in the lumbar more expanded, and intermediate in width in the cervical; in all, however, its posterior surface is divided from the dura mater by fine areolar tissue, which is usually of a reddish colour and watery character.

Both the anterior and posterior common ligaments are highly inelastic; and flexion and extension of the spine depend upon displacement, or rather thinning of the intervertebral disc, according as temporary but undue pressure is brought to bear on it.

Supraspinous Ligaments are visible only in the dorsal and lumbar regions, but not in the cervical, where the ligamentum nuchæ takes their place, the latter being a strong fibrous band, attached

above to the occipital protuberance, and below to the prominent spine of the seventh cervical vertebra, sending off as it passes downwards thin prolongations, which are connected to the intervening spines, forming a species of septum between the muscles of opposite sides; from the point where it terminates the supraspinous properly commences, stretching as a rounded cord from the summit of one dorsal spine to that of the next, but on reaching the lumbar region its character becomes altered, as it is here flattened out and much stronger, forming a powerful bond of union between the adjacent bones, and giving origin to the erectors of the spine.

Interspinous are also deficient in the cervical region, their place being supplied by muscles, while in the dorsal they are thin and diaphanous, triangular in shape, and extremely weak, but in the lumbar, where they are quadrilateral in figure, they are very thick and strong; they extend, as their name implies, from the under part of one spine to the upper of the adjoining; and require a very tedious and troublesome dissection to expose them.

Intertransverse.—This name has been applied to a few scattered fibres which extend between the adjacent transverse processes; they are very irregular in their arrangement, sometimes not existing at all, at least we have looked in vain for them in repeated instances, but even when present they can contribute very slightly indeed to the strength of the spinal column.

Capsular.—Found encircling the contiguous articulating processes of adjoining vertebræ, and have been most incorrectly described as being very weak and imperfect, but such is not the case, as they are exceedingly strong, and completely surround the joint, the synovial membrane of which they protect, while they confer no small degree of security on the articulation; the removal of the dense mass of muscles which overlap, and take an origin from them is, however, an operation tedious, and attended with much trouble.

Ligamenta Subflava, have been so named from their bright yellow colour, which is very beautifully seen in the fresh preparation; and as it is always better to observe them internally, the posterior portion of the section which has been already made to expose the posterior common ligament of the spine, will enable us to obtain an excellent view of them. They consist of thick masses of ligamentous tissue, stretching between the corresponding laminæ, composed of fibres closely packed together, converging and meeting at an angle posteriorly, so as completely to fill up the intervals left between the adjoining vertebræ; their attachment, however, to the laminæ is peculiar, for while they spring from the upper and outer edge of the one below, they are inserted into the lower and inner margin of

the one above, an arrangement conferring a high degree of smoothness and regularity on the internal part of the spinal canal. They vary, however, in strength in the several regions of the spine, being exceedingly strong in the lumbar and dorsal, but weak and much deeper from above downwards, in the cervical. Their elasticity is also very remarkable, acting in this respect as a powerful adjuvant to the great muscles of extension.

The form of ARTICULATION of the spine is amphiarthrosis, with one single exception, that between the oblique processes, which is arthrodia, and it possesses all the motions,—rotation, circumduction, flexion, extension, and lateral inclination. The first of these, or rotation, scarcely deserves this name, as it is rather a movement of torsion of the intervertebral disc, being extremely limited between any two contiguous vertebræ, but when diffused amongst several, it can be carried to a considerable extent. Circumduction is, however, much more extensive; in this motion the apex of the cone is at the upper part of the sacrum, and the base formed by the superior parts of the body. The amount of flexion is apparently very great, but if we except the cervical region, it is really very limited, for the curvature which is generally ascribed to the spinal region truly depends upon the bending forwards of the body at the coxo-femoral articulation, while the power of extension is still more circumscribed, owing to the protrusion backwards of the spinous processes, and to the peculiar manner in which they overlap each other in the dorsal vertebræ, but above all to the position of the sternum and linea alba in front, which act as a powerful restraining medium in this movement, and hence we always find it better marked in the cervical region where these have no existence. Lateral motion partakes in a great measure of the character of the last described, and is least limited in the lumbar and cervical regions. Here it may be necessary to repeat what we have before stated generally,—that flexion, extension, and lateral motion depend not on the absolute stretching of the connecting tissues, but on the degree of displacement of the soft portions of the intervertebral disc; as, to whatever side the body may be inclined, there it becomes thinned, while it is thickened on the opposite side, in consequence of the larger portion of the disc being forcibly pressed in that direction.

ATLANTO-AXOID ARTICULATION.

The union between the first and second vertebræ takes place at three distinct points, viz., between the two oblique processes at either side; and between the odontoid of the one with the back

part of the body of the other. For the security of this joint it is provided with an anterior, and a posterior ligament, a capsular on each side, and a transverse.

Anterior Ligament.—This consists of a lamina of fibres, particularly dense in the mesial line, stretching from the tubercle of the atlas, and the anterior surfaces of its contignous half-arches, to the front of the body of the axis, where it becomes blended with the anterior common ligament; it is exceedingly strong, and is partially covered by the tendinous insertions of the longus colli.

Posterior Ligament.—Weaker and thinner than the last, extending between the posterior half-arches of the atlas, and upper edges of the laminæ of the axis, and seems to be typical of the ligamenta subflava in the other regions. The inferior oblique muscle must be removed in order to expose it.

Capsular Ligaments, are compact, and possessed of great strength, particularly anteriorly and externally, but at the same time sufficiently lax to admit of the great amount of motion that exists between the atlas and axis; they are attached to the edges of the corresponding oblique process, and are lined by a synovial sac, which is remarkable for its great extent.

Transverse Ligament, strong and dense, stretching across the spinal foramen in the atlas, to be attached by its extremities to two small tnbercles, situated on the inner side of its lateral masses; it is grooved anteriorly, where it lies in contact with and embraces the odontoid process of the axis, but flattened posteriorly, where it is covered by the apparatus ligamentosns colli; from its inferior margin a strong fibrons process descends, which is inserted sometimes into the back part of the body of the axis, and sometimes into that of the third cervical vertebra, while from its upper, another occasionally ascends, but mnch weaker, which is implanted into the edge of the foramen magnnm. The circular canal, formed by the bone in front and the ligament behind, is lined by a loose synovial sac, which is sometimes double, but which appears to be much too large for it. The superior border of the ligament likewise forms a larger segment of a circle than the inferior, an arrangement which, from the constriction of the odontoid process at its junction with the body of the bone, has a tendency to keep the parts more inseparably united.

This articulation is componnd,—arthrodial between the oblique processes, and lateral ginglymns between the odontoid and body of the atlas. Its principal, and indeed only, motion is rotation, and this is by no means as extensive as we wonld on a cursory view be led to snppose, as in turning the face to either side the whole of the

vertebral column, more particularly its cervical portion, assists in the motion.

OCCIPITO-AXOID ARTICULATION.

The union between the occipital bone and axis is indirect, the atlas intervening and separating them, and hence it is merely syndesmoid. The means of connexion are three powerful ligaments,—the apparatus ligamentosus colli, and the check, moderator, or odontoid ligament, and according to some the ligamentum suspensorium.

Apparatus Ligamentosus Colli.—To expose this ligament it will be necessary to have a skull with the calvarium and brain removed, when an incision must be made with a saw vertically downwards, so as to divide the foramen magnum laterally, about its centre; the cut should again be continued downwards to about the fourth cervical vertebra, and by dividing the spinal column at this point we will have the internal part of the canal, and the edge of the foramen magnum exposed; by now dissecting off the dura mater, the ligament will be brought into view, when it will be found to be exceedingly strong, and may be said to consist of three distinct parts,—a median, and two lateral; of these, the median is dense, taking its origin from the edge of the foramen magnum, and, passing downwards nearly vertically, crosses the transverse ligament, into which a great part of its deep fibres are inserted, while the more superficial continue their course, to be implanted into the back part of the axis, where they become blended with the posterior common ligament of the spine. The lateral portions arise more externally from the margin of the occipital hole, where they are extremely broad, and as they descend, incline slightly inwards, and gradually becoming narrower, are attached to the back part of the axis, where they join the middle fasciculus; the relations of this ligament are, behind the dura mater, and in front the odontoid process, transverse, and check ligaments.

Check, or Moderator Ligaments.—Exposed by dissecting off the last described, are two rounded ligamentous cords, about three quarters of an inch in length, arising from a slight furrow on the upper part of the odontoid process, and passing nearly transversely outwards, are inserted into a small depression on the inside of the condyloid process; they are strong, and their use is to limit over-rotation of the atlas, and of course the head, which is attached to it, on the axis; this can be clearly shown on the dissected preparation, where we are enabled to turn the head to a certain extent, and no further, the ligaments in this condition being found twisted around the odontoid process, the insertion of one of them being directed

partially backwards, and of the other partially forwards. With respect to their relative anatomy we will find the anterior occipito-atlantoid ligament lies in front of them, and the apparatus ligamentosus colli behind them, except at their insertion, where they are covered by dura mater.

Ligamentum suspensorium would appear to be nothing more than a deep process of the apparatus ligamentosus colli, merely consisting of a few scattered fibres, stretching from the anterior edge of the foramen magnum to the tip of the odontoid process.

OCCIPITO-ATLANTOID ARTICULATION.

In this joint, the occipital bone and the atlas are in contact at two distinct points, but it possesses only one motion, which is that of opposition, and for this reason it is termed condyle-arthrosis; it is a most important articulation, requiring great strength, and accordingly we find that it has numerous ligaments for its security; these consist of an anterior which is double, a posterior, two lateral, and a capsular, with very loose synovial membranes.

Anterior Occipito-Atlantoid Ligament.—To expose this, the pharynx must be removed in the usual manner, but in doing so we must be careful to make the section accurately between the cephalo-pharyngeal aponeurosis and the recti muscles, so as to leave the latter attached to the basilar process; the muscles may be now detached from the bone, and reflected downwards, when the fat and areolar tissue having been removed, this ligament will be brought into view, consisting, as has been observed, of two distinct portions, an anterior, and a posterior; the first of these, always well-marked, is rounded and cord-like in appearance, attached above to the basilar process, from which it stretches downwards, to be inserted into the tubercle, on the front of the atlas; posteriorly it rests upon the flattened portion, with which it is intimately blended; anteriorly it is covered by the recti majores, while on each side it has the two lesser recti, as they converge to their insertion into the basilar process; the posterior portion, weaker than the last, but much broader, particularly below, arises from the anterior lip of the foramen magnum, extending out on each side nearly as far as the condyles, and descends almost vertically to be inserted into the upper edge of the anterior half-arch of the atlas; it rests posteriorly on the point of the odontoid process and check ligaments, which separate it from the apparatus ligamentosus colli, while anteriorly it is covered by the greater and lesser recti, and its own rounded portion.

Posterior Occipito-atlantoid Ligament, comes into view on removing all the muscles from the back part of the neck till we reach

the oblique and recti, and on separating these from the occipital bone, and removing the fat, we will observe the ligament much weaker in its character than the preceding, but broader and laxer; it takes its origin from the posterior edge of the foramen magnum, as far forwards as the condyles, and is inserted into the upper surface of the posterior half-arch of the atlas; it is perforated by two foramina, one large, for the vertebral artery, the other small, for the suboccipital nerve, and it corresponds by its anterior surface to the dura mater of the cord, and by its posterior to the superior oblique and recti muscles, with the vertebral artery, which rests on it for a short distance.

Lateral Occipito-Atlantoid Ligament, is exposed by removing all the soft parts immediately over the transverse process of the atlas, and then detaching the rectus capitis lateralis from the occipital bone, and reflecting it outwards, when the ligament, never well-marked, consisting only of a few scattered fibres, will be seen arising from the jugular ridge, and descending to be inserted into the root of the transverse process of the atlas; externally it is covered by the rectus lateralis; internally it corresponds to the articulation between the atlas and occipital bone; while anteriorly it assists in completing the fibrous canal, which contains the internal carotid and jugular vein, and the eighth, ninth, and sympathetic nerves.

Capsular Ligaments, consist of a series of fibres, the majority passing almost vertically downwards, and interlacing with others running in an oblique direction from the edge of the condyle above to the atlantoid articulating depression below; externally and anteriorly they are exceedingly strong; but internally and posteriorly very weak and indistinct, affording rather a protection to the synovial membrane than any security to the joint itself. This is a double arthrodial joint, but with ginglymoid motion only, and hence called an artnrodial ginglymus; it is very remarkable for the extreme size and laxity of the synovial membrane, which is reflected downwards in loose folds, on the edges of the articulation.

COSTO-SPINAL ARTICULATIONS.

The articulation between the ribs and spinal column is a double arthrodia, as the former unites by its head with the bodies and intervertebral substance of two contiguous vertebræ, and by its tubercle with the extremity of the transverse process of the vertebra below. The ligaments, which tend to secure each of those articulations, are three in number: those of the first, or the costo-vertebral, being an anterior or stellate, a middle or intervertebral, and a posterior or

imperfect capsular; while those of the second, or costo-transverse, are an anterior, middle, and posterior.

Stellate, or Anterior Costo-vertebral.—May be exposed with great facility in a subject, from the thorax of which the soft parts have been removed, by simply dissecting off the costal pleura, with the fibrous membrane which lies beneath it, and turning on one side the dorsal ganglia of the sympathetic, the dissection being greatly facilitated by sawing across all the ribs anterior to their angles. The stellate ligament, which is thus brought into view, is of a triangular shape, narrow externally, but broad internally; it arises by a thick, narrow process from the anterior surface of the head and neck of the rib, and passing inwards divides into three distinct parts, the superior being inserted into the vertebra above, the inferior into that immediately below, and the middle into the intervertebral substance; it differs, however, in its mode of insertion in the first, eleventh, and twelfth, being attached to a single vertebra in each of those instances, although it still consists of three slips. This ligament, exceedingly strong, rests on the contiguous bones and cavity of the joint, and is covered by some loose fibrous tissue, with the dorsal ganglia of the sympathetic, and the pleura.

Capsular Ligament.—In order to examine this, it will be necessary to detach from the back all the large muscles which cover it, and then by a cautious dissection the ligament will be perceived, consisting of a few scattered fibres stretching from one bone to the other. Although very apparent posteriorly, it is weak and indistinct anteriorly, where it is scarcely required, the strong stellate ligament taking its place.

Intervertebral Ligament.—May be exposed by dividing the stellate ligament, as well as the capsular; the attachment of the tubercle of the rib to the transverse process must likewise be cut through, and then, by pulling it slightly apart from the spine, the intervertebral ligament may be observed arising from the ridge or crest between the two articular facettes on the head, and stretching directly inwards, to be inserted into the side of the intervertebral disc. In its character, it is comparatively weak, and flattened from above downwards, so as to form a septum or partition between the two synovial membranes, which line the superior and inferior articulations.

Anterior Costo-transverse Ligament.—Is extremely strong, but flattened, being fully exposed in the dissection already made, as it arises from the under surface of the extremity of the transverse process of the vertebra above, and stretching downwards and inwards, is inserted into a slight crest or ridge on the upper edge of the neck of the rib below, which it thus directly supports. It appears to be a thickened portion of the fibrous membrane which covers the external

intercostal muscles, and corresponds, anteriorly, to the anterior intercostal vessels and nerves, and a quantity of loose areolar tissue; posteriorly, to the longissimus dorsi; internally, to the posterior dorsal vessels and nerves as they pass through a quadrilateral opening intercepted between it, the bodies, and transverse processes of the adjacent vertebræ; and, externally, to the levator costæ.

Posterior Costo-transverse.—Is a strong band of fibres, stretching between the extremity of the transverse process, and non-articular portion of the tubercle of the rib; and is covered in by the insertion of the erectors of the spine, and the levatores costarum.

Middle Costo-transverse.—Is truly an interosseous ligament, possessing only a slight degree of strength. It is very difficult to obtain a good view of it, but a partial one may, however, be gained by dividing all the other ligaments, and forcibly tearing the rib from the transverse process, when we may observe its fibres stretching irregularly from one facette to the other; it is likewise provided with a synovial membrane.

The articulations just described, remarkable for their strength, admit of very slight motion, strictly speaking; but this motion, trivial as it may appear to be when viewed at the points where it actually does take place, is found to be amply sufficient for the proper distention of the thorax, when propagated along the curved lever which the rib represents. In its movement of elevation and depression, the tubercle gliding to a certain extent on the transverse process, communicates a species of semirotatory movement to the head, which plays in the socket formed by the contiguous vertebræ and intervening intervertebral substance. This articulation is likewise a double arthrodia.

CHONDRO-COSTAL AND CHONDRO-STERNAL ARTICULATIONS.

The union between the ribs and their cartilages is very peculiar: the extremities of the former being excavated, and into these the cartilages are implanted, while the periosteum is continued uninterrupted from one to the other; the connexion between them being very intimate, although there are no ligaments for their security. The cartilages are in the same manner imbedded in grooves in the sides of the sternum, having according to some authorities a synovial membrane interposed, but this we have hitherto been unable satisfactorily to demonstrate. They are connected to the sternum by a superior and inferior, with an anterior, and posterior ligament.

The Superior, and Inferior Ligaments scarcely deserve the name of such, being merely processes of fibrous tissue extending from the sides of the sternum to the upper and lower margins of the costal

cartilages ; but the anterior, and posterior are much better marked, particularly the former, which stretches obliquely from the anterior surface of the cartilage of one side, decussating with its fellow across the sternum, to reach that of the opposite side. It is covered by the aponeurosis of the great pectoral muscle.

The Posterior Chondro-sternal.—Much weaker than the last, but arranged in a similar manner, presenting the same radiated appearance on the back part of the sternum, as the other did on its front, and it corresponds to the anterior mediastinum, and the parts contained in it.

SACRO-VERTEBRAL ARTICULATION.

The union of the spinal column with the sacrum is closely analogous to that of the vertebræ with each other, but is remarkable for the great vertical depth of the intervertebral disc in front, and its equally striking shallowness behind, contributing in a great measure to the production of that prominence which is so conspicuous at this point, known as the sacro-vertebral angle. In addition, however, to those ligaments which it has in common with the spine, it likewise possesses another peculiar to itself, termed the sacro-vertebral, a strong fasciculus of fibres, which extends from the transverse process of the fifth lumbar vertebra, and is inserted into the back part of the base of the sacrum, where it becomes blended with the sacro-iliac ligaments. The sacro-vertebral ligament is, however, extremely hard to dissect and demonstrate, owing to the manner in which the tendinous origins of the erectors of the spine are blended with it.

SACRO-COCCYGEAL ARTICULATION.

This is an arthrodial joint in early life, although at a later period it becomes a synarthrosis, the two bones composing it being united by ossific deposit. Its mode of connexion consists of an anterior and posterior ligament, and a thin disc of fibro-cartilage.

Anterior Sacro-coccygeal Ligament.—Usually consists of two distinct bands, with a slight interval between them, stretching from the anterior surface of the sacrum to the front of the coccyx. It is, generally speaking, comparatively weak ; and to expose it, the rectum must be removed, with some loose areolar tissue, and the coccygeal ganglion of the sympathetic.

Posterior Sacro-coccygeal.—Stretches from the last tubercles on the lower edge of the sacrum to similar processes on the upper part of the coccyx, thus completing the termination of the spinal canal. It is rather stronger than the anterior, and is covered by the glutæus maximus, which likewise takes an origin from it.

The Fibro-cartilaginous Disc is thin as contrasted with those between the bodies of the vertebræ, being always, however, much denser in the female than in the male.

The strength of this articulation is greatly increased by the origin of the sciatic ligaments, which, attached to the sides of the sacrum and coccyx, form a strong bond of union between the adjacent bones.

ILIO-LUMBAR ARTICULATION.

There is no direct union between the last lumbar vertebra and the ilium, but they are connected together by a powerful ligament—the ilio-lumbar. This arises narrow, from the under part of the transverse process of the fifth lumbar vertebra, and, becoming broader and more expanded, is inserted into the posterior superior spinous process, and a part of the adjacent crest. The strength of this ligament is much increased by the muscles that are attached to it—the glutæus maximus, and iliacus internus springing from it below, while the latissimus dorsi, erectores of the spine, and quadratus lumborum take an origin from it superiorly. It is a syndesmoid articulation, nearly the strongest of that class in the whole body, and may be exposed without difficulty by removing the muscles that have been enumerated.

SACRO-ILIAC ARTICULATION.

This belongs to the class amphiarthrosis, and is formed by the apposition of the sacrum and os innominatum. To examine this joint properly, it will be necessary to divide the horizontal ramus of the pubis immediately external to its spine, carrying the saw afterwards through the thyroid hole, and then through the ascending ramus of the ischium; by now forcibly tearing asunder the sacro-iliac symphysis of the corresponding side, we will be enabled to examine the joint under consideration, as well as the symphysis pubis, and both sacro-ischiatic ligaments on the opposite one.

The Sacro-iliac Synchondrosis has for its security, anterior and posterior ligaments, with a dense cartilage of incrustation.

Anterior Ligament.—This requires very little preparation—merely the removal of the great vessels and nerves, and a little loose areolar tissue, when it is brought into view, consisting of a series of parallel fibres of unequal lengths, stretching from the adjacent surface of one bone to that of the other, by no means remarkable for their strength. This ligament is covered by the lumbo-sacral nerve, and internal iliac arteries.

Posterior Ligament.—Requires a very tedious dissection to see

it properly, as all the muscles on the back of the sacrum must be removed, the ligament in question lying deeply between its spines and the posterior edge of the ilium. In its character it differs completely from the preceding, as it consists of three or four triangular fasciculi of exceeding strength and thickness, stretching between the tubercles on the back of the sacrum, and the adjacent non-articular surface of the ilium; when these are cautiously removed, another and deeper set is brought into view, much weaker and in direction, horizontal, and running parallel to each other between the contiguous edges of the two bones. They are, as we have already stated, covered by the origins of the lumbar mass of muscles, and rest on the bones from which they are separated by a quantity of loose areolar tissue, through which ramify several very large veins.

Having examined those ligaments, they may now be divided; and having torn the bones forcibly from each other,—an operation sometimes of great difficulty, as they are generally more or less anchylosed,—the intervening cartilage may be observed; it is extremely thick, particularly on the sacrum, and so intimately connected to the surfaces of both bones, as to render the joint by this arrangement very secure, even without the aid of its ligaments. It has been said that a synovial membrane can be detected in this articulation both in childhood and in the female during the period of pregnancy. Now with respect to the first there is no doubt, that a structure bearing a close resemblance to a tissue of this nature does exist; but in the case of the latter its identity is very questionable, at least we have never had an opportunity of demonstrating it. From repeated examinations made, however, to enable us to judge of the fact, it may be safely stated that the motion that does exist in the articulation is very limited; indeed, in the great majority of cases, scarcely perceptible; a circumstance that might be inferred without testing it at all, owing to the powerful nature of the connecting media with which it is furnished.

LATERAL LIGAMENTS OF THE PELVIC OUTLET.

Are two in number, commonly called the greater and lesser sacrosciatic, from the marked difference in size. The greater, which is also external, and of an irregular hour-glass figure, but much broader posteriorly than anteriorly, arises behind from the posterior-inferior spine of the ilium, and from the side of the sacrum and coccyx, extending on the latter bone for about its first and second pieces; it stretches obliquely downwards, forwards, and outwards, becoming very constricted as it crosses the lesser sciatic notch, but again expanding on reaching the tuberosity of the ischium, into the inner

lip of which it is inserted, as well as into its ascending ramus, where it becomes continuous with the base of the triangular ligament. Its internal margin is prolonged inwards and slightly upwards for some distance, under the name of the processus falciformis, and this uniting with the obturator fascia leaves a slight interval between it and the obturator muscle, for the reception of the pudic vessels and nerves, while its external expands over the pyriformis muscle.

The great sciatic ligament, is covered externally and posteriorly, by the glutæus maximus, which is very closely adherent to it; and more anteriorly, by the hamstring muscles which arise from it; while internally it corresponds to the lesser sciatic ligament, and coccygeal branch of the ischiatic artery, and with the fat filling up the ischio-rectal fossa.

Lesser Sacro-sciatic Ligament.—Triangular in figure, with the base posteriorly, and apex anteriorly, is attached behind to the side of the sacrum and coccyx, and taking a more horizontal course than the greater, is inserted into the posterior edge of the spine of the ischium; it is also much weaker and shorter than the preceding, internal to which, and to the coccygeal branch of the sciatic it lies, while internally it corresponds to the coccygæus muscle, and fat in the ischio-rectal fossa.

Exclusive of their evident use to complete the inferior outlet of the pelvis, these ligaments must likewise confer on the cavity a great amount of strength, from the mode in which they are stretched between its two fixed points, connecting them like the stays of a chain bridge, without at the same time interfering with the important parts that pass through the notches, which they circumscribe, and which have been already enumerated in the general description of the pelvis.

OBTURATOR LIGAMENT.

May be exposed by removing carefully the two muscles of the same name, which are closely attached to it, when it will be seen to be thin, but extremely strong and unyielding, and composed of fibres interlacing with each other, so as to give it a reticular appearance; it is attached posteriorly, and externally, to the outer edge of the obturator foramen; and anteriorly, and internally, to its posterior, thus completely filling it up, except superiorly, where an aperture is left, but very oblique in its nature for the passage of the vessels and nerves. As we have already remarked, it is in contact by both its surfaces with the obturator muscles.

SYMPHYSIS PUBIS.

Is an amphiarthrodial joint, possessing a slight degree of motion. It is formed by the two ossa pubis of opposite sides, but it is to be observed that while they do not touch anteriorly, the interval existing between them in this direction, being filled up in the natural state of the parts by a dense fibro cartilage of a wedge-shape, with the base turned forwards, and closely adherent by its lateral surfaces to the opposite bones, they are in absolute contact posteriorly. The ligaments for the security of the joint are anterior, and posterior, superior and inferior.

Anterior Ligament, may be brought into view by cautiously removing the parts attached to the anterior part of the crest, when it will be found to consist of a series of oblique fibres, stretching from one bone to the other, those of the left side crossing in front of those of the right. They are seldom very well marked, and are covered by the decussating tendons of the external oblique muscle, which thus adds materially to their strength.

Posterior Ligament, may be exposed by removing the fascia from the back part of the symphysis. It differs from the preceding in the arrangement of its fibres, which are more transverse and much weaker, while it is concealed by the pelvic fascia, as it dips downwards to terminate in the true ligaments of the bladder.

Superior Ligament.—Strong, rounded, and cord-like, apparently a continuation of Poupart's ligament, extends across the whole of the upper edge of the crest, from the spine of one side to that of the opposite, becoming exceedingly thick opposite the articulation; it gives attachment to the muscles of the abdomen, particularly the recti.

Inferior Ligament, stretches across between the rami of opposite sides, immediately beneath the symphisis. It is broad at its points of attachment, but rounded and flattened out about its middle, presenting an arched appearance, with the concavity directed downwards. It forms the principal bond of union of the articulation, and its strength is still further increased by the triangular urethral ligament, with which it is in some degree continuous below.

Interpubic Fibro-cartilage.—In order to obtain a proper idea of this structure, a horizontal section, from before backwards, must be made across the joint about its centre, by which means its wedge-like appearance will be at once understood. In the disposition of its fibres it bears a close resemblance to those of the discs of the spinal column, being densest at the margins, and semifluid and pulpy in the centre. Like those of the discs also they cross each other very obliquely, to be firmly implanted into the contiguous surfaces

of the opposite bones, forming a medium of connection, of the strength of which any one may satisfy himself, by endeavouring forcibly to tear the parts asunder.

ILIO-FEMORAL ARTICULATION.

This is a true enarthrosis, or ball-and-socket joint, the deep cup or acetabulum of the os innominatum receiving the globular head of the femur, and as it is an articulation the functions of which are so incessantly called into play, nature has taken great pains to confer on it a proportionate degree of strength, depending not only on its ligamentous but also on its muscular connexions. The ligaments of the joint consist of the following :—the capsular, the accessary or ilio-femoral, teres or round, the cotyloid, and transverse.

Capsular.—In order to examine this ligament, all the muscles around the articulation must be cautiously removed, as well as the loose areolar tissue which is sometimes very abundant in this situation, and when perfectly exposed, we observe it to be of a dull, opaque, white colour; in shape cylindrical, but much more capacious above than below,—attached superiorly around the acetabulum, but not to the cotyloid ligament, which lies free within it, separated from it by the synovial membrane, which is inflected between them; it passes downwards and outwards, and is inserted inferiorly into the anterior intertrochanteric line, and posterior part of the neck of the femur, at the junction of its external with its two internal thirds, so that it is much longer in front than behind. As a ligament, it is tense and strong, especially superiorly and externally, where the principal weight of the body is thrown, as in progression, but internally and inferiorly it is comparatively laxer and weaker. It is covered almost in every direction by muscles, and these must in a great measure contribute to its power of resisting displacement of the bones which it encloses. Thus we find the psoas and iliacus, with internal head of the rectus sweeping down in front of it, and controlling the very motion which would have a tendency to rupture the capsule in this direction, viz. :—over-extension, as their tendons are naturally brought to the highest pitch of tension under those circumstances, and this of course, must have a powerful influence in keeping the bone firmly fixed in its socket. Again, it is strengthened on the outside by the glutæus medius, and minimus, and the outer head of the rectus, and more posteriorly, by the several rotators outwards; inferiorly, the tendon of the obturator sweeps beneath it, partially supporting it in forced abduction; while internally not only the origin of the last-named muscle, but likewise those of the adductors, contribute materially to its security.

Ilio-Femoral or Accessory Ligament.—A dense, flattened band of fibres, apparently a thickened portion of the capsule, arises from the anterior inferior spinous process of the ilium ; and passing from this point downwards, backwards, and outwards, is inserted into a rough space anterior to the lesser trochanter. In its course it rests upon the capsule, and is covered by the tendons of the psoas and iliacus, while its use is to prevent over-rotation inwards, and extreme extension; this can be easily shown by forcibly attempting either of those motions, when it becomes exceedingly tense, and resists every effort to carry them beyond a certain point.

Ligamentum Teres, or Round Ligament.—The capsule must be divided, and the head of the bone dislocated, to bring this ligament into view, and when the synovial membrane which invests it is cautiously dissected off, the ligament is seen to arise by two small crura from the upper and lower edge of the notch in the acetabulum ; they now proceed outwards, backwards, and upwards, and unite into one, but again diverging from each other before reaching the head of the bone; it is inserted into a depression below and behind its transverse axis. As a ligament, it is of very little use indeed to confer security on the joint; but it forms the medium by which the vessels are conducted to the head of the bone, as well as a means of reflecting the synovial membrane from it to the acetabulum. From its being so closely connected to the Haversian gland, it may be likewise of service in moving it, so as to fill up the several interstices which would otherwise take place in the various motions of the joint.

Cotyloid Ligament, fully exposed by the removal of the capsular, is attached all round the brim of the acetabulum, the cavity of which it deepens to a considerable extent, while at the same time it fills up all its depressions and sinuosities, and renders its free border completely level in its character. A section of it would represent nearly an equilateral triangle, the base of which would be attached to the margin of the bone, while the free border would form a smaller circle than the other, and closely embrace the neck of the femur in the natural condition of the parts; it is also much denser and stronger above and behind than at any other point, because this is the part on which the entire weight of the body is thrown when in the upright position. The fibres composing this ligament do not observe a concentric arrangement, but, springing from all parts of the margin of the acetabulum, they decussate with each other at a very acute angle, and terminate finally in its free margin, in a kind of rounded cord. Its extremities, on reaching the notch, are prolonged across it; the one from above being inserted into its lower lip, and that from below into its upper, leaving between them and the edge

of the bone an irregular foramen, for the passage of the vessels and nerves for the supply of the articulation.

Transverse Ligament.—This is sometimes very obscure, consisting merely of a few fibres stretching across to complete the interval which must exist between the decussating extremities of the cotyloid ligament, as the latter dip backwards to their separate points of insertion.

In addition to those ligaments already described, there is another peculiar to the femur alone, called the cervical; it is found surrounding the neck, extending obliquely upwards and inwards, from the insertion of the capsular to the sinuous line which defines the head, and usually consists of strong ligamentous fibres rarely continuous, covered by folds (retinacula) of the synovial membrane (Stanley's Ligament).

Synovial Membrane.—This envelopes the head of the bone, covers the acetabulum and ligamentum teres, sending off, besides, two small processes, one into the narrow groove which separates the cotyloid ligament from the cartilage of incrustation, and another, which becomes blended with a mass of fat, found in the inferior and internal part of the acetabulum, known as the Haversian gland, supposed by Havers to have been placed there for the purpose of secreting the synovial fluid, but erroneously, as its only use is to fill up the interstices that would otherwise exist in the varied motions of the joint.

The Motions of the ilio-femoral articulation are very numerous, consisting of flexion, extension, abduction, adduction, circumduction, and rotation.

Flexion.—This motion is very extensive, and may be carried so far that the anterior surface of the thigh and abdomen will come in contact, while the head of the femur rolls in the acetabulum on an imaginary axis, represented by a line passing upwards and inwards through its neck, dislocation being here prevented by the agency of the gluteus maximus which closely envelopes it posteriorly.

Extension.—This is exceedingly limited, as any attempt at carrying the thigh backwards, beyond the axis of the body, brings the neck of the femur in contact with the lower edge of the acetabulum, which, forming a fulcrum, throws the head prominently forwards, thus protruding the capsule; but the ilio-femoral ligament, and the tendons of the psoas, iliacus, and rectus, are by this very act immediately rendered tense, and thus powerfully resist all further movement in this direction.

Abduction is very considerable, the laxity of the capsule internally permitting the head to glide partially out of the cotyloid cavity, the great trochanter at the same time pointing towards the ala of the ilium. This, however, has the effect of bringing the upper and con-

cave part of the neck in contact with the edge of the acetabulum, and so preventing in a great measure the dangerous results that might ensue by permitting further motion in this direction.

Adduction is extremely slight, as the meeting of the thighs limits it at once; but if either be slightly flexed, it may be carried over the other for some extent. The ligamentum teres and the rotator muscles, however, becoming tense, prevent its being carried beyond a certain point.

Circumduction.—This is merely the revolution of the limb, forming a cone, the apex being at the joint, with the base below formed by an imaginary circle described by the foot. This motion is limited when in the upright position, but may be carried to a considerable extent by sitting on the edge of a table, and thus getting the opposite leg out of the way.

Rotation.—In this motion the head turns slightly in the socket, the axis of rotation corresponding to an imaginary line supposed to be passed from the head to the internal condyle. This movement is always better marked in this articulation than in that of the shoulder, owing to the obliquity of the neck of the femur, as it allows the muscles to act at a material advantage—a fact that cannot apply to the short and straight neck of the humerus.

FEMORO-TIBIAL ARTICULATION.

One of the most important articulations in the whole body, remarkable alike for the number of its ligaments, and for the position of a series of tendons so disposed as not only to confer great strength, but likewise to perform the office of ligaments when their functions as tendons are no longer of value. It belongs to the class of angular ginglymus; but as it possesses a slight degree of rotatory motion, it is of course incomplete, though in all other respects it exhibits the usual characteristics of this form of articulation. Its media of connexion consist of, firstly, an imperfect capsule; secondly, an anterior ligament; thirdly, a posterior, or that of Winslow; fourthly, an external; fifthly, an internal; sixthly, a mucous; seventhly, two alar; eighthly, two crucial; ninthly, ligament of Wrisberg; tenth, coronary; eleventh, transverse; and twelfth, two semilunar cartilages to deepen the cavity of the tibia for the reception of the condyles of the femur, while the bones which enter into its formation are three; the femur above, the tibia below, and the patella in front.

Imperfect or Surgical Capsule consists of three layers, the fascia lata most superficially, beneath which is an expansion from the adjacent tendons; and, still deeper, a thin fibrous layer from the surrounding ligaments. The first of these, or the fascia lata, extremely

strong in this region, is stretched tensely across, and firmly inserted into the condyles at each side, adhering to the surface of the patella as it passes over it; while below it is attached to the tibia internally and externally, and to its tubercle in front. When this layer is cautiously removed, the second, or that derived from the expansion of the tendons, viz., from the rectus anteriorly, the vasti laterally, and the semimembranosus behind, is exposed; and, like the preceding, is inserted around the head of the tibia, being very dense immediately over the front of the joint. The third layer, or that from the ligaments, is thin; but its existence can, nevertheless, be clearly demonstrated, its principal use apparently being to confine the large synovial sac which lines the articulation, within its proper cavity.

Having concluded the examination of the capsule, it, as well as the tendons surrounding the joint, may be removed, when the ligaments may be detached from the synovial membrane, and separately examined.

Anterior Ligament, or Ligamentum Patellæ, is situated immediately in front of the articulation, and both from its position and general character would evidently appear to be a continuation of the common extensors of the leg; the patella being interposed as a sesamoid bone, in order to bestow a different direction on their tendon. It arises by a broad origin from the point and anterior surface of the bone alluded to, and, passing nearly vertically downwards, is inserted into the lowest part of the tubercle of the tibia, decreasing considerably in transverse width as it descends, but becoming much thicker from before backwards. It rests posteriorly and superiorly on a quantity of fat which separates it from the joint, and lower down on a bursa which intervenes between it and its tùbercle of insertion; while in front it is in relation with the capsule already described, and two bursæ which are situated near its extremities. The fibres of this ligament, when submitted to maceration, are found to take a vertical direction, and to be united together by a fine areolar tissue.

Ligament of Winslow, is a broad aponeurotic band, given off from the outer margin of the semi-membranosus tendon, and, stretching upwards and outwards from this point over the posterior condyloid notch, is inserted into the external condyle of the femur; it is further strengthened by numerous fibres borrowed from the poplitæus and gastrocnemius,—the whole forming a ligament of vast strength; its deeper layer being connected to the edges of the tibia, and margins of the semilunar cartilages; spreading out over the condyles at each side, so as to invest them with a kind of sheath, and passing up superiorly, to be lost in the masses of fat found on the flattened posterior aspect of the femur; inferiorly it becomes continuous with the deep fascia of the leg; while opposite the flexure of the joint

it is perforated by an oblique foramen, for the passage of the azygos artery, for the supply of the joint, with its two accompanying veins, the hole for the articular branch of the obturator nerve being a little internal to it. This ligament corresponds by its anterior surface to the back part of the tibia, semilunar cartilages, posterior crucial ligament, intercondyloid notch, and poplitæus muscle; and by its posterior, to the popliteal vessels and nerves with their branches, to the heads of the gastrocnemius, plantaris, tendon of the semi-tendinosus, and a large quantity of adipose tissue. In extension it is extremely tense, while in flexion it becomes relaxed.

External Lateral Ligament.—Strong, rounded, and cordlike, but broader at its points of attachment than in the middle, arises from a tubercle on the outer side of the external condyle, immediately above the popliteal groove, and, taking a direction downwards and backwards, is inserted into the upper part of the head of the fibula. In its course downwards it crosses the tendon of the poplitæus, which separates it from the external condyle, and the inferior external articular artery, which divides it from the semilunar cartilage of the same side, while the tendon of the biceps lies at first posterior, but afterwards becomes external to it. This ligament occasionally bifurcates inferiorly, and under such circumstances, its second insertion is into the outer part of the head of the tibia.

Internal Lateral Ligament.—Diamond-shaped, differing from the preceding in being much flatter, broader, and stronger, arises from a tubercle on the inner side of the internal condyle, below the insertion of the adductor magnus, and passing downwards and forwards, is inserted into the inner and anterior part of the tibia, a little below its head. It crosses in its course downwards the internal semilunar cartilage, to which it is firmly attached, the tendon of the semimembranosus, and the inferior internal articular artery, both of which last separate it from the tibia; while its internal surface is crossed by the tendons of the sartorius, gracilis, and semitendinosus, as they arch forwards to their insertion. Both the external and internal lateral ligaments being attached posterior to the axis of motion, are of course relaxed in flexion and rendered tense by extension. Rotation of the leg inwards will also slightly relax them.

Mucous Ligament, exposed by throwing downwards and forwards the patella, consists of a fold of synovial membrane, enveloping a thin process of fibrous tissue derived from the transverse ligament; it is attached above, to the intercondyloid fossa, and below to the mass of fat which lies immediately behind the patella.

Alar Ligaments, are likewise processes of the synovial membrane —lateral appendages of the mucous, stretching downwards along the sides of the patella to the fat in front of the joint. The use of these

and the preceding is to act upon the adipose tissue, and to cause it to fill up the several interstices that would otherwise exist within the cavity of the joint during its various motions.

CRUCIAL LIGAMENTS, are two in number,—an anterior or external, and a posterior or internal. In order to obtain a good view of their course and attachments, all the external ligaments should be removed, as well as the mucous and alar, with the synovial membrane which is reflected round them, and the lower part of the femur should then be split vertically downwards by a cut that will pass antero-posteriorly directly between the condyles. The anterior crucial ligament, arises broad from a depression in front of the spine of the tibia, and taking a direction obliquely backwards, upwards, and outwards, is inserted into the inner side of the external condyle; while the posterior, taking an origin from a notch behind the spine, posterior to the cornua of both semilunar cartilages, and passing upwards, forwards, and inwards, is attached to the outer side of the internal condyle. From this arrangement it will be observed that those ligaments cross each other as they proceed to their destination at an oblique angle, and hence their name. Both are exceedingly strong; and as they are attached behind the axis of motion, become relaxed in flexion, but are rendered tense in extension,—a motion which they completely limit, if attempted to be carried to excess. The decussation can be removed, and the ligaments brought parallel to each other, by rolling the leg outwards. In their origin from the head of the tibia, it will be recollected that the anterior is intimately connected to the anterior horn of the internal semilunar cartilage; and the posterior, which is the more vertical, to the posterior cornu of the external.

LIGAMENT OF WRISBERG.—Is not always to be found, and when present it appears to be only an offset from the posterior crucial. It is attached to the posterior edge of the external semilunar cartilage, and is inserted into the outer side of the internal condyle in front of the posterior crucial ligament. Its use appears to be, to fix the posterior cornu of the external semilunar cartilage, and to prevent its displacement.

SEMILUNAR CARTILAGES.—In order to examine these, it will be necessary to detach the femur from the tibia, by cutting across the crucial ligaments—leaving, however, a small portion connected to the latter bone, in order to observe more closely their attachments. The semilunar cartilages are two in number, an internal, and external; both as their name implies being crescentic in shape, but the cornua of the first are so far apart as to allow those of the external, which is more circular, to be grasped or embraced by them. In describing those cartilages it will be necessary to give them a superior and inferior surface, an internal and external margin, and an anterior

and posterior cornu. Of these the superior surface is concave, and corresponds to the convexities of the condyles of the femur, while their inferior is convex, and is accurately moulded on the glenoid cavities of the tibia. Their external margins are thick, and attached to the bone by some scattered fibres, termed the coronary ligament, and folds of the synovial membrane, called retinacula; their internal edges are thin and sharp, and pass in on the articular surfaces of the bone, but, to an unequal extent—the external covering nearly the whole of that portion of the head of its own side, while the internal leaves a large part of its corresponding tibial depression free. The cornua are sharp and pointed; those of the external being inflected towards each other so as to approximate very closely, and are inserted into the fossa between the two prominences constituting the spine of the tibia; but those of the internal are separated by a broader interval, and are severally attached to slight depressions, anterior and posterior to the spine, embracing the insertions of the preceding. It will be likewise recollected, that the internal lateral ligament is firmly connected to the circumferential margin of the internal cartilage; but the same rule does not apply to the external, as it is separated from its corresponding ligament by the tendon of the poplitæus and inferior external articular artery. The use of the semilunar cartilages, is to deepen the cavities of the head of the tibia for the reception of the condyles of the femur, and to adapt it to the varying convexities of the latter, as well as to break those shocks to which the joint would be otherwise liable from its construction, the bones which composeit being nearly perpendicular to each other.

Coronary Ligament.—Has been already cursorily alluded to. It consists merely of a few scattered bands of fibrous tissue, passing from the edges of the tibia to the margins of the semilunar cartilages, but they are sometimes very difficult to be demonstrated.

Transverse Ligament.—Must be exposed by a cautious removal of the fat in front of the joint, when it will be found to be a thin but strong band of fibrous tissue, attached on either side to the anterior margins of both semilunar cartilages; its obvious use is to prevent the separation of these cartilages from each other—an accident to which they would be otherwise always liable from their wedgelike shape, as by the weight of the body transmitted to the condyles they are necessarily compressed and hence as naturally forced outwards.

Synovial Membrane.—This is one of the most capacious of this class in the whole body; it lines the entire cavity of the joint, covers the articular extremities of the bones and the semilunar cartilages, invests the crucial ligaments, is reflected around the fat behind the

patella, over the posterior surface of which and its proper ligament it is also spread out; it also throws off distinct folds, forming the mucous and alar ligaments already described, and, passing upwards beneath the extensor tendons, forms a large *cul de sac*, which extends for some distance between the vastus internus and the bone.

Adipose Tissue.—Is found in a great quantity in this joint, as in addition to the large mass which is situated immediately behind the ligamentum patellæ, it occupies likewise the space between both condyles. It always exists, even after the most wasting diseases, which only appear to modify its structure by rendering it of a more watery character, without, however, sensibly diminishing its volume.

Motions.—These are confined to flexion and extension, with slight rotation.

Flexion.—Is most extensive, and limited only by the leg and thigh coming into direct contact posteriorly; in this motion the head of the tibia glides upon the rounded condyles of the femur, relaxing all the ligaments but that of the patella, which becomes extremely tense and prominent; the knee in this condition presents generally a rounded form, owing to the position of the patella, which covers in the depression which would otherwise naturally exist between the bones, and which forms a kind of shield for its protection, while so firmly is it fixed in the trochlea of the femur while in this position that it resists every effort to displace it.

Extension can be only carried so far as to bring the thigh and leg to a straight line, but any motion beyond this is impossible, as all the ligaments, with the exception of the ligamentum patellæ, are on the stretch; the several tendons also which glide behind the condyles are in the same state, and actively resist further motion in this direction; the knee may, in fact, be compared to a hinge at present much used by mechanics, and this, from its peculiar construction permitting motion in one direction only, while it limits it completely in the opposite, has been called a stop-hinge.

Rotation.—Is very inconsiderable, and may be said to exist only in semiflexion; in this motion the internal condyle of the femur is fixed, while the external glides slightly backwards and forwards in the corresponding socket of the tibia; the active agents in producing this motion being the biceps and popliteus, the former pulling the head of the fibula, and, of course, the outer part of the tibia, to which it is firmly connected, backwards, while the latter replaces it in its original position; rotation is more extensive outwards than inwards, owing to the peculiar arrangement of the crucial ligaments, as in the first they are untwisted, and become nearly parallel to each other, while in the second their decussation is increased, thus limiting effectually all further attempts at inversion.

TIBIO-FIBULAR ARTICULATION.

The tibia and fibula articulate with each other above and below, forming at each point a plane arthrodial joint, the motions of which are of a gliding character, but so very inconsiderable that by many high authorities they are said not to exist at all; they are secnred by very strong ligaments, particularly inferiorly, while a powerful interosseous membrane serves as a further bond of union between the bones.

Superior Tibio-fibular Ligaments.—Consist of an anterior and posterior, composed of very strong fibres, running obliquely from above and within, downwards and outwards; they are so extremely tense that they scarcely permit the slightest motion between the contiguous surfaces; and are covered in by the tendinons origins of the extensor longus, and those of the peronæus longus and solæus, while a synovial membrane, sometimes isolated, but sometimes continuous with that of the knee, lines the joint.

Interosseous Ligament.—Extends between the adjacent margins of the bones for a great part of their length, but is deficient above for the passage of the anterior tibial vessels, and below for the anterior peroneal; it is exceedingly strong, the majority of its fibres running from within, downwards and ontwards, but traversed by others fewer in number, and taking a contrary direction; besides its use as a ligament, it likewise serves to give origin to the numerous muscles which are found in this region.

Inferior Tibio-fibular Ligaments.—Are three in number—an anterior, a posterior, and an interosseous; the two first are very strong, composed of dense white fibrous tissue, running in parallel fascicnli from the anterior and posterior parts of the tibia, downwards and outwards, to the corresponding margins of the external malleolus; being prolonged, particularly the posterior, below the cdges of the tibia, and thus tending to increase materially the depth of the articular socket for the reception of the astragalus. From the fact that the fasciculi which compose thesc ligaments are occasionally interrupted by a considerable interval, many anatomists have been led to describe them as double, particularly the posterior one, but the instances are so rare in which this peculiarity has been observed, that it ought to be regarded as nothing beyond an ordinary anomaly. The anterior ligament is covered by the extensor, and the posterior by the flexor tendons.

Interosseous or Middle Tibio-fibular Ligament.—This is so completely cnveloped in adiposc tissue that it is sometimes difficult to find it, but when that has becn removcd, its white shining fibres will be observed decussating with each other, and extending for some

distance between the adjacent bones ; its remarkable strength may be tested by dividing the anterior and posterior ligaments, when the attempt to separate the bones will often be found an operation of some difficulty, the fibula in the majority of instances fracturing, during the trial, a few inches above the malleolus.

Synovial Membrane.—Is a process derived from that of the ankle-joint.

ANKLE-JOINT.

The tibia, fibula, and astragalus enter into the formation of this articulation, which, from the motions which it possesses, is termed an incomplete angular ginglymus ; its great strength and security depend not only on the powerful ligaments with which it is supplied, but also on the manner in which the bones that compose it are arranged—the two malleoli, with the anterior and posterior tibio-fibular ligaments, constituting a very perfect socket for the reception of the trochlea of the astragalus, while the several tendons springing from the muscles attached to the leg, likewise act as auxiliary media in conferring additional security on the articulation. Its ligaments consist of an anterior, a posterior, an external, and an internal lateral.

Anterior Ligament.—Is exposed by removing the extensor tendons from the front of the joint, but this must be done with great caution, as the ligament is very weak in its character ; it arises from the whole of the convex surface of the tibia, a little above its inferior border, and from this it descends to be inserted into the upper part of the astragalus, close to its head ; it is lax and of little use as a means of connexion, but it serves to protect and confine the synovial membrane within the joint.

Posterior Ligament.—Is brought into view, by removing the flexor tendons, and is much weaker than the last, so much so that its existence has been altogether denied by several anatomists ; it can, however, be generally demonstrated as a thin layer of lax fibrous tissue, stretching between the inferior margin of the tibia superiorly, and the groove behind the trochlear surface of the astragalus inferiorly, its use being similar to that of the last.

External Lateral Ligament.—Consists of three distinct slips or processes—an anterior, a posterior, and a middle ; the first of these, short but broad, arises from the anterior edge of the external malleolus, from which it stretches downwards, forwards, and inwards, to be inserted into the outer side of the neck of the astragalus ; it is covered by the peroneus anticus ; the middle process, extremely strong and rounded, takes its origin from the inferior extremity of the malleolus, from which it descends, with a slight obliquity back-

wards, to be inserted into a tubercle on the outer side of the os calcis; it is partially covered by the sheath of the peronei tendons; the posterior, long and nearly horizontal, is attached to a depression on the inner and posterior part of the malleolus, and proceeding inwards and backwards is implanted into the edge of the astragalus external to its tubercle posteriorly; sending off from this point three processes—one superiorly and internally, to the back part of the tibia; one directly internally, to bind down the flexor pollicis in its groove; and one inferiorly, to be inserted into the upper part of the os calcis. To the posterior slip of the external lateral ligament, the term interosseous might with great justice be applied, as it lies within the joint, running nearly parallel to the posterior tibio-fibular ligament.

Internal Lateral Ligament.—Is much stronger than the preceding, and composed of continuous fibres, but is much broader below than above, and hence its name, deltoid; it arises narrow from the inferior extremity of the internal malleolus, and, passing downwards, its posterior fibres are inserted into a rough space on the inside of the astragalus, behind its articular facette; its middle, a short dense mass, into the sustentaculum tali; and its anterior into the inner side of the scaphoid bone, where it is connected to the calcaneo-scaphoid ligament. Of all these processes, the last is the weakest and longest, and the middle strongest and shortest; it is partially concealed by the tendons of the tibialis posticus and flexor communis, as they cross in their course to reach their insertion.

In addition to those ligaments already described the ankle-joint is furnished with a series of others, termed annular, beneath which the several tendons run to their destination in the foot. The annular ligaments are three in number, called, from their position, the anterior, external, and posterior or internal; the first being devoted to the passage of the extensor, the second to those of the peronei, and the third to those of the flexor tendons.

Anterior Annular Ligament.—Quadrilateral in shape, but broader internally than externally, consisting of a series of strong transverse fibres, stretching obliquely from the front of the internal malleolus, and scaphoid bone, downwards and outwards, to be inserted into the anterior surface of the external malleolus, and os calcis: it is composed of two distinct layers, of which the superficial is much the stronger. Those layers are connected by two septa, leaving between them three distinct canals for the passage of the extensor tendons; of these, the most internal is occupied by the tibialis anticus, the middle by the extensor pollicis, and anterior tibial vessels and nerve; the two layers in this instance lying superficial to those parts; whilst the most external accommodates the extensor communis and peroneus tertius. This ligament is continuous above

with the fascia of the leg, and below with the thin aponeurosis on the dorsum of the foot.

External Annular Ligament.—Short, but very strong, is attached above and anteriorly to the outer and back part of the external malleolus, and below and behind to the outer part of the os calcis posterior to its tubercle; it is divided into two compartments by a thin septum, affording passage to the tendons of the peroneus longus, and brevis.

Posterior, or Internal Annular Ligament.—More dense and strong than either of the two preceding; arises from the back part of the internal malleolus, and is directed downwards and backwards, to be inserted into the internal and posterior part of the os calcis. It, like the anterior, is divided into three canals by two septa,—the most internal being traversed by the tibialis posticus, and flexor digitorum communis, but separated from each other by a thin process of fibrous tissue; the middle by the posterior tibial vessels, and nerve; and the most external by the flexor pollicis proprius. This ligament has united to it, superiorly the fascia of the back part of the leg, and inferiorly the internal process of the plantar, and one head of the abductor pollicis.

Synovial Membrane.—Is common both to the ankle-joint and the inferior tibio-fibular articulation; it forms a loose fold anteriorly and posteriorly, but is tense laterally,—an arrangement that might be inferred from the peculiar motions of the joint.

Motions.—These, according to very high, and indeed the best, authorities, are confined simply to flexion and extension; rotation or lateral motion, however limited, being impossible, from the peculiar mechanism of the joint.

Extension.—This movement is remarkable from the manner in which the articular surfaces of the opposing bones become altered in their relations to each other; the trochlea of the astragalus glides forward beneath the inferior extremity of the tibia, so that the posterior lip of the latter rests on the groove of the former posteriorly; beyond this, extension cannot be carried, as the anterior portions of the internal and external lateral ligament, with the extensor tendons, are put violently on the stretch, and present an insurmountable obstacle to further motion in this direction.

Flexion.—Is the reverse of the other; the trochlear surface of the astragalus, carried backwards behind the tibia, projects posteriorly, while the anterior lip of the tibia rests on the neck of the astragalus; an excess in this movement is limited by the tension of the posterior portions of the internal and external lateral ligaments with the tendons posteriorly, which actively oppose its being carried beyond a certain extent.

A combination of several circumstances confers on the ankle-joint an unusual degree of security, and these it may be as well to recapitulate. In the first place, owing to the tibia falling on the astragalus at a right angle, the weight of the body in the upright position is transmitted in a manner admirably calculated to prevent displacement under natural conditions. Secondly, the socket formed by the malleoli on either side, with the tibio-peroneal ligaments in front and behind, and receiving within it the elevated trochlea of the astragalus, constitutes a complete morticed joint, admitting only of those motions calculated to favour progression, but carefully guarding against any rotatory or lateral movement, except such as might depend on the elasticity of the fibula, which might be highly dangerous without adding materially to its useful functions; while thirdly, as we have already observed, the tendons which surround the articulation, acted on by the vital agency of their corresponding muscles, are stationed like sentinels to watch over and preserve the bones which compose it from displacement, except under extraordinary circumstances.

CALCANEO-ASTRAGALOID ARTICULATION.

This is a double arthrodia, the two bones which compose it coming in contact at two distinct points,—posteriorly and externally, and anteriorly and internally; the means of union between them being an interosseous, an external, and an internal ligament.

Interosseous Ligament.—It is to be premised, that for the examination of all the connecting media of the foot, it will be necessary that all the soft structures should be removed; but this must be done with great care, as the tendinous origins of the numerous muscles of this region are intimately blended with the ligaments. But to form a just conception of the one at present under consideration, both the astragalus and os calcis must be sawn through from before backwards, which will enable the student to obtain a lateral view of it—the only manner in which he can acquire a proper idea of its true character; it consists of a series of oblique and vertical fibres of great strength, mixed up with a quantity of fat stretching between the astragalus above and the os calcis below, and occupying the groove which exists between them; they are amply sufficient, except under the most peculiar circumstances, to maintain the union between the bones, and are broader and stronger externally than internally.

External and Internal Lateral Ligaments consist, of a series of short fibres, stretching between the adjacent margins of the bones on each side, but they scarcely deserve the name that has been ap-

plied to them, as they are sometimes incapable of demonstration; the sheaths, however, of the flexor tendons confer a vast amount of security on the articulation, both posteriorly and internally.

Synovial Membranes.—That of the posterior articulation is peculiar to it alone, and is very lax in its nature, while that of the anterior is smaller, and continuous with the astragalo-scaphoid.

Motion is exceedingly limited, and merely of a gliding character.

ASTRAGALO-SCAPHOID ARTICULATION.

Is an arthrodial joint, formed by the convex and oval head of the astragalus, fitting into a corresponding oval depression on the back part of the scaphoid; properly speaking, it has only a single ligament for its security, situated superiorly, and composed of a series of strong fibres springing from the upper part of the neck of the astragalus, from which it passes forwards to be inserted into the upper and posterior magins of the scaphoid bone; it is tense in its character, while a loose synovial membrane, prolonged from the calcaneo-astralagoid articulation, lines the joint.

Motion.—Very extensive, as the elasticity of the foot may in a great measure be referred to the union between those two bones.

The admitted strength of this articulation, must by no means be inferred to depend on the simple ligamentous connexion just described, as its security is referrible to causes much more remote and more complex. A single glance would be sufficient to show that, as far as the contiguous surfaces of the bones are concerned, displacement downwards would appear to be the obvious consequence of force applied to them from above, the shallow cup in the scaphoid being quite insufficient to contain the large head of the astragalus; but nature, ever provident, has been careful to guard against the occurrence of such an accident by placing beneath the articulation the calcaneo-scaphoid ligament, which, while it deepens the cavity, at the same time supports the head of the bone. But of still greater efficacy in effecting this object is the position of the tendon of the tibialis posticus, which with its sesamoid bone developed in it, and rendered tense at the moment its assistance is more particularly required, winds beneath the head of the astragalus to its insertion, and forms an active ligament to sustain the pressure transmitted from above, and resist the natural tendency to displacement downwards.

CALCANEO-CUBOID ARTICULATION.

In this joint the anterior extremity of the os calcis articulates

with the posterior of the cuboid, and as the surfaces are alternately concave and convex, the union therefore takes place by a process termed mutual reception; its ligaments are a superior, an inferior, and internal.

Superior Calcaneo-cuboid Ligament lies immediately under the extensor digitorum brevis, which must be removed in order to see it. The fibres which compose it are rather weak, and stretch from the upper and anterior part of the os calcis to the posterior margin of the cuboid bone.

Inferior Calcaneo-cuboid Ligament consists, properly speaking, of two distinct portions,—a superficial, originally known as the ligamentum longum plantæ, and a deep, the ligamentum breve plantæ. The first is a dense, shining, pearly band, extending from the whole of the under surface of the os calcis, nearly as far back as its tubercles, horizontally forwards to the inferior part of the cuboid, to be inserted into the anterior and posterior lips of the peroneal groove, so as to assist in forming the sheath of that tendon as it passes through it, and into the rough space immediately behind it, while in its character it is exceedingly strong and unyielding. The deep portion is brought into view by cautiously removing the preceding, with a small quantity of adipose tissue which lies between them. It is shorter and weaker than the last, and is attached behind to a ridge on the anterior part of the os calcis, and in front to the margin of the cuboid. The musculus accessorius must be removed in order to expose both those ligaments.

Internal Calcaneo-cuboid Ligament, is merely a continuation of the superior, but much thicker and stronger in its nature, and connects the adjacent surfaces of the bones on their inner side. In order to bring it into view, the fat and areolar tissue between the os calcis and astragalus externally, must be removed.

The calcaneo-cuboid is a very secure joint, not only from the peculiar adaptation of the contiguous surfaces, but likewise from its powerful ligamentous connexions; yet in the amount of mobility which it possesses, it is by no means to be compared with that of the astragalo-scaphoid articulation.

INDIRECT ARTICULATION OF CALCANEUM AND SCAPHOID.

This is syndesmodial, as the two bones are at no point in apposition with each other. They are, however, connected by two powerful ligaments, a superior and inferior, the latter of which is by far the stronger.

Inferior Calcaneo-scaphoid Ligament.—Broad, thick, and triangular in shape, arises from the under surface and anterior part of the

os calcis, and running inwards and slightly forwards from this point, passes between the head of the astragalus above and the tendon of the tibialis posticus below, where it is almost cartilaginous, to be ultimately inserted into the tubercle on the inferior or inner part of the scaphoid, as well as into the adjacent surfaces of that bone. Besides forming a bond of union between the two bones under discussion, its use with regard to the head of the astragalus has been already alluded to. It is concealed by the musculus accessorius, and long flexor tendons.

Superior Calcaneo-scaphoid Ligament, is smaller and weaker than the last, extending between the anterior edge of the os calcis and the outer side of the scaphoid. It appears to be an offset from the internal calcaneo-cuboid ligament, and must be exposed in the same manner.

UNION BETWEEN THE SCAPHOID AND CUBOID BONES.

Is sometimes immediate, as small articular facettes may exist on the adjacent surfaces of the bones for mutual contact, while at other times they are not in direct apposition; still, however, in either circumstances, they are united by a strong interosseous, and a superior and inferior ligament.

Interosseous Ligament, is short, but of great strength, and consists of a series of fibres, some transverse and some decussating, stretching between the opposite bones.

Superior Ligament, is a narrow, flat band of fibres, extending obliquely outwards, from the upper surface of the scaphoid to the corresponding one of the cuboid.

Inferior Ligament.—Much stronger and thicker than the preceding, arises from the outer edge of the tubercle of the scaphoid, and is inserted into the inner side of the cuboid, becoming continuous with the sheath of the peroneus longus. It is concealed by the origins of the deeper layer of the plantar muscles.

This articulation is very strong, as may be proved by the difficulty experienced in endeavouring to tear the bones forcibly from each other.

ARTICULATIONS BETWEEN THE SCAPHOID AND CUNEIFORM BONES.

The three cuneiform bones, are in direct contact with the scaphoid; and are united by dorsal, plantar, and interosseous ligaments.

Dorsal.—Are narrow slips, extending between the superior surfaces of the adjacent bones; but in the articulation between the internal cuneiform and the scaphoid, the fibres pass directly for-

wards, while between the other two they pass obliquely forwards and outwards.

Plantar.—Are nearly analogous to the preceding, but are much weaker, with the exception of that for the internal, which forms a dense fibrous cord which becomes blended with the second insertion of the tendon of the tibialis posticus. This last articulation likewise presents a well-marked internal lateral ligament, stretching between the inner surfaces of the contiguous bones.

Interosseous Ligaments, are short, strong fibres, some transverse, others decussating, interposed between the non-articular portions of the adjacent bones.

UNION BETWEEN THE CUBOID AND EXTERNAL CUNEIFORM.

Is precisely similar to the last, consisting of dorsal, plantar, and interosseous ligaments; and they therefore require no separate description, while the synovial membrane is continuous through all the articulations just described.

ARTICULATION OF THE CUNEIFORM BONES WITH EACH OTHER.

These bones partly lie in contact with each other, and are partly separated by intervals of unequal lengths. They are connected together by dorsal, plantar, and interosseous ligaments.

Dorsal.—Are broad bands, thin but strong, stretching from bone to bone, nearly transversely across their upper surfaces; and being covered by the extensor tendons, are difficult of demonstration.

Plantar.—Are nearly analogous to the last, but situated on the under surface of the foot, where they are concealed by the deeper layer of plantar muscles.

Interosseous.—Are very dense, consisting both of transverse and decussating fibres, and forming the strongest bond of union between the bones in question.

TARSO-METATARSAL ARTICULATIONS.

Are all arthrodial, and present such a varied ligamentous connexion, that it will be necessary to examine each separately. We will accordingly begin with the first.

1. The first metatarsal bone articulates with one tarsal bone, and the internal cuneiform; its bond of union consisting of two ligaments, a superior or dorsal, and an inferior or plantar. They are each formed by strong fibrous bands passing between the adjacent bones, the inferior being much the best marked. The tendon of the tibialis

anticus gliding over the upper and inner part, and the peroneus longus over the inferior and internal, add materially to the strength of the articulation. Its synovial membrane is peculiar to itself.

2. The second metatarsal bone articulates with the three cuneiform, being completely wedged in between them, and is maintained in this position by dorsal, and plantar ligaments. Of these, the former consists of three distinct bands, the most internal passing from the upper surface of the internal cuneiform bone, forwards and outwards, to be inserted into the head of the metatarsal bone; the middle, of great strength, stretches horizontally between the middle cuneiform, and the same bone; and the external, the weakest, between the third cuneiform, but with a similar insertion; all being covered by the extensor tendons. The plantar, are only two in number, and nearly of the same strength; the most internal extending from the first cuneiform, forwards and outwards; and the external from the second, directly forwards, to be implanted into the sharp ridge on the under surface of the second metatarsal bone. They are covered by the deep plantar muscles.

3. The third metatarsal, articulates with the third cuneiform only, its ligaments being a dorsal, and plantar. The former of these is a strong bundle of fibres extending between the adjacent bones, but the latter weak and indistinct, and partly blended with the sheath of the peroneus longus.

4. The fourth metatarsal articulates with the cuboid, and slightly with the external cuneiform; it has a dorsal ligament, which is double, but no plantar. A narrow but strong band of fibres springing from the outer edge of the third cuneiform, is implanted into the corresponding outer margin of the fourth metatarsal bone, while a second arises from the upper surface of the cuboid, and passing horizontally forwards is inserted into the head of the same bone. An expansion of the sheath of the peroneus longus serves as its plantar ligament.

5. The fifth metatarsal articulates with the cuboid only, and has one oblique dorsal ligament, extending forwards and outwards from the upper surface of the cuboid, to the head of the metatarsal bone; but it derives additional security from other sources. Thus, below it is strengthened by the sheath of the peroneus longus, and externally by the insertion of the peroneus brevis, and outer process of the plantar aponeurosis, which is inserted into the spur of the metatarsal bone.

Synovial Membranes.—Are three in number, divided between the five metatarsal bones, in the following manner,—one, as we have already stated, is confined exclusively to the first; another to the second and third; and another to the fourth and fifth.

UNION OF THE METATARSAL BONES WITH EACH OTHER,

Is amphiarthrodial, the bond of union being by dorsal, plantar, and interosseous ligaments. The dorsal are a series of fibres, passing from the upper surface of one bone to the corresponding surface of the other, forming, in fact, a continuous band from the inside to the outside of the foot, the plantar being precisely similar in their arrangement, but much thicker and stronger. Their principal security, however, depends on the interosseous ligaments, which stretch between the adjacent sides of the several bones, and are short, but endued with vast strength.

UNION OF THE DIGITAL EXTREMITIES.

These are not in contact with each other, but still are united by a tranverse ligament of tolerable strength, though sufficiently loose to admit of free motion, which is further facilitated by a synovial membrane interposed between each.

UNION OF THE METATARSAL BONES WITH THE PHALANGES.

Those articulations constitute an imperfect angular ginglymus, the head of each metatarsal bone being received into the cup of the corresponding phalanx, and are connected, in this position, by an external and internal lateral, and a superior and inferior, ligament.

The External, and Internal, Lateral, strong and thick, arise from a tubercle situated a little behind the head of the metatarsal bone, and passing forwards and downwards, becoming broader in their course, are inserted into the sides of the adjacent phalanges.

Inferior Ligament, of great strength, particularly opposite the articulation, is attached in front to the inferior lip of the first phalanx, from which it stretches backwards, to be implanted into the under part of the neck of the metatarsal bone. Its principal use is to deepen the articulation, a strong expansion uniting it to the lateral ligaments on either side.

Superior Ligament, is always very indistinct, and consists of only a few ligamentous fibres extending between the adjacent bones. It is, however, strengthened and covered by a strong expansion from the extensor tendons.

Synovial Membrane, distinct for each joint.

Motion.—Flexion and extension in a marked degree, but abduction and adduction limited.

ARTICULATIONS OF THE PHALANGES WITH EACH OTHER.

These are complete angular ginglymi, possessing only motions of opposition, or flexion and extension, but the mode of union between them being precisely similar to that of the last described, it would be to no purpose to repeat them.

The Foot must be regarded as the basis of support of the entire weight of the body; and with this object in view, nature has been more anxious to confer on it strength and solidity to enable it to perform this office effectually, than to endue it with that delicacy of movement, which has been so lavishly expended in the construction of the hand. We accordingly find that the motions, generally speaking, are those of a gliding nature, as far as the tarsus and metatarsus are concerned, but with a slight power of abduction, adduction, and torsion between the first and second rows of the former, while in the latter as well as the phalangeal articulation, the mobility is greatly increased, flexion and extension prevailing to a very marked extent, so as to confer elasticity in progression, without, however, compromising in the slightest degree the amount of strength which is so essential to the security of this important part.

LIGAMENTS OF THE UPPER EXTREMITY.

Sterno-clavicular Articulation, is formed by the union of two bones,—the extremity of the clavicle, and the upper and lateral part of the sternum. From the peculiar configuration of the articulating surfaces, alternately concave and convex, it is a joint by mutual reception, having for its security an anterior, a posterior, and an interclavicular ligament, with a thick intervening fibro-cartilage.

Anterior Ligament, consists of a series of strong fibres stretching obliquely downwards and inwards, from the anterior surface of the clavicle to the front of the sternum.

Posterior Ligament, is nearly similar to the preceding, but situated on the back part of the adjacent bones, a few scattered fibres on the upper surface of the articulation connecting both together, and rendering them in some degree orbicular. It is right, however, to remark that one very high authority considers the posterior ligament the stronger of the two; but this we have never found to be the case in the repeated instances in which we have had an opportunity of examining them. The anterior, always derives additional strength from the inner origin of the tendon of the sterno-mastoid, the fibres of both being intimately blended with each other.

Interarticular Fibro-cartilage, is exposed by dividing the preceding ligaments close to the sternum, and bending the clavicle

downwards, when it will be seen to be rather triangular in figure, and extremely thick at its margins, which are closely united in front and behind, to the anterior and posterior ligaments, but in the middle it is sometimes altogether deficient; its blunted apex is attached below to the sternum, at the point where it articulates with the cartilage of the first rib, and its rounded base above to the extremity of the clavicle, thus forming a very elastic cushion between the two bones, and so tending to break those shocks to which this joint is peculiarly liable from falls, &c.

INTERCLAVICULAR LIGAMENT.—Exceedingly strong, stretching between clavicle and clavicle, where it is firmly attached to their non-articular extremities, as well as for some distance to their upper surfaces; concave superiorly, it is united to the deep fascia of the neck; and convex inferiorly, it is connected to the fourchette of the sternum, and posteriorly to the pericardium. If a section is made of this ligament, it is found to be extremely dense, and triangular in shape.

SYNOVIAL MEMBRANES, are two in number; separated from each other by the fibro-cartilage, except the latter is perforated when they communicate freely with each other. A third synovial sac occasionally exists, between the lower edge of the clavicle and the cartilage of the first rib, evidently placed there for the purpose of enlarging the articulating surface, for the former to play upon.

MOTIONS.—Forwards, backwards, upwards, and downwards. In the first of these, or the motion of the shoulder forwards, the articular surface of the clavicle glides backwards, and puts the posterior ligament on the stretch; while in that backwards, the clavicle bulges forwards, and carries before it the anterior ligament, so that the limitation of both these movements depends upon the unyielding nature of those media of connexion. When the shoulder is elevated, the clavicle glides outwards on the facette of the sternum; the rhomboid or costo-clavicular ligament, and subclavius forming the check to prevent this motion from being carried to a too great extent; while in depression, the clavicle slips forwards and upwards, and its shaft or body, coming in contact with the first rib, offers a strong barrier to its sinking farther in this direction, except with an amount of violence capable of producing dislocation.

COSTO-CLAVICULAR ARTICULATION.

The inferior part of the sternal extremity of the clavicle and the cartilage of the first rib, are generally in contact with each other, and are united by a strong ligament, called from its shape the rhomboid, which arises from the upper edge of the cartilage of the

first rib, and passing upwards and outwards, is inserted into a rough ridge on the inferior surface of the clavicle. This ligament is of great importance, in strengthening the sterno-clavicular articulation, and preserving the bones which compose it in the requisite apposition with each other.

CORACO-CLAVICULAR ARTICULATION.

This is syndesmodial, as the bones which compose it are not in apposition with each other, but are connected by two powerful ligaments, deriving their name from their shape,—the conoid, and trapezoid,—the former being triangular, and situated on a plane posterior and internal to the latter, which is quadrilateral in figure. The conoid takes its origin by a narrow-pointed extremity from the upper surface of the coracoid process near its root, and passes upwards to be inserted by a broad base into two tubercles on the posterior edge of the inferior surface of the clavicle. The trapezoid, on the other hand, is attached to the inner lip of the coracoid process, and stretches obliquely upwards and outwards, to be implanted into a rough ridge on the under part of the clavicle, a little external and anterior to the other. Those ligaments, on their external aspect, appear to be single, and are, in fact, more or less continuous; but on viewing them from the inside, an interval of a triangular shape, exists between them, into which are prolonged a few fibres of the subclavius muscle, with a small quantity of adipose tissue. The coraco-clavicular ligaments, are endued with great strength; their obvious use being to prevent dislocation of the clavicle upwards on the acromion process of the scapula, while they likewise in a great measure limit the backward and forward movement of the shoulder, which might be otherwise carried to a dangerous extent, as far as the security of the sterno-clavicular articulation is concerned.

ACROMIO-CLAVICULAR ARTICULATION,

Is an arthrodial joint, formed by the union of the outer end of the clavicle with the inner side of the acromion process, and is connected by two ligaments,—a superior and inferior, with occasionally an interarticular fibro-cartilage.

Superior Ligament, exposed by removing the deltoid, and trapezius, with their aponeurosis which covers the articulation, consists of a series of dense, strong fibres, stretching from the upper surface of the clavicle, to that of the acromion process, being much stronger posteriorly than anteriorly.

Inferior Ligament, is similar to the last, but weaker in its

character. It is always covered with a quantity of adipose tissue, from which it is sometimes exceedingly difficult to isolate it.

Interarticular Cartilage.—This we have very rarely had an opportunity of observing, but when it does exist, it is always thin, and only occupies the upper part of the articulation.

Synovial Membrane.—Small, and merely sufficient to cover the opposing articulating surfaces; it is sometimes deficient.

Motions.—These are both gliding and rotatory; both being pretty extensive, from the looseness of the connecting ligaments. The security of the articulation is much increased by the manner in which the two great muscles, the deltoid and trapezius, embrace it before and behind,—serving, in fact, as powerful ligaments to guard against displacement.

LIGAMENTS PROPER TO THE SCAPULA,

Are exposed by removing all the muscular attachments from that bone, when they will be brought into view, consisting of the coraco-acromial, or triangular, the transverse, and the spino-glenoid.

Coraco-acromial or Triangular Ligament is a very powerful band of fibres, extending between the two processes of the scapula —the acromion and coracoid—immediately above the shoulder-joint. It arises, by a narrow-pointed process, from the under surface of the acromion, and passing downwards and inwards is inserted by a broad base into the outer and superior border of the coracoid, for its whole length; its anterior edge being prolonged into a thin fascia separating the deltoid from the articulation; while its posterior becomes continuous with the fascia covering the supraspinatus. This ligament, with its under surface lined by a distinct synovial sac, and with the processes to which it is attached, constitutes a perfect vault or arch, beneath which the head of the humerus plays, thus preventing dislocation upwards of that bone. A striking change sometimes takes place in the character of this ligament, as in a recent dissection, we found it to be completely ossified. It is covered by the deltoid muscle, and lies upon the supraspinatus, and a quantity of fat.

Transverse Ligament, is a strong bundle of fibres, stretching from the root of the coracoid process, backwards to the posterior edge of the notch in the superior costa of the scapula, thus converting the notch, alluded to, into a foramen, through which the suprascapular nerve runs to its destination, while the suprascapular artery passes above it, usually perforating the omohyoid tendon, which generally arises from it by a broad origin, and partially conceals it from view. Its use appears to be merely to protect the nerve, as it passes over the sharp margin of the bone, from undue pressure.

Spino-glenoid.—Scarcely deserves the name of a ligament, as it is usually constituted by a little areolar tissue stretching from the under part of the spine of the scapula to the outer lip of the glenoid cavity. The use formerly assigned to it,—of supporting the glenoid cavity of the scapula if the neck of that bone was fractured, and so preventing it and the head of the humerus from sinking into the cavity of the axilla, is obviously incorrect, as for that purpose it is unquestionably too weak; but it may be of some service in protecting the branch of the suprascapular artery, as it descends beneath it to the infraspinous fossa, from the pressure of the adjacent muscles.

SCAPULO-HUMERAL ARTICULATION.

This is an arthrodial joint, into the formation of which, portions of two bones only enter, viz., the head of the humerus, and glenoid cavity of the scapula; these are connected by four ligaments,—the capsular, accessory or coraco-humeral, glenoid, and inter-articular.

Capsular.—In order to obtain a view of this ligament, the upper extremity must be detached from the trunk in the usual manner; the deltoid, and coracoid muscles cut across at their origin and thrown down; and the capsular, treated in the same manner; but their tendons of insertion must be left untouched, in order to observe their relative position, with respect to the articulation. The capsule thus exposed resembles in figure a sack open at both extremities,—the superior, which is the smaller, being closely applied around the neck of the scapula; while the inferior is attached to the depression immediately above the tubercles of the humerus, known as its anatomical neck. It must not, however, be regarded as sufficiently tense, to preserve the bones to which it is attached in close apposition; on the contrary, it is exceedingly lax, and permits an interval of separation between them, varying from half to three-quarters of an inch; nor is it equally strong in all directions,—for while superiorly and externally, it is dense and remarkably unyielding; inferiorly and internally, it is comparatively weak and thin. The fibres which compose it, take generally a longitudinal course, stretching from the neck of the humerus to that of the scapula; but an open space usually exists between them at the upper edge of the subscapularis, through which a fold of the synovial membrane escapes to communicate with the bursa that separates its tendon from the bone; a second opening, likewise, being occasionally found in the position of the infraspinatus tendon. The capsular ligament is in relation, above with the supra-spinatus; externally, with the infra-spinatus, and teres minor; inferiorly and posteriorly, with the long head of the triceps; and internally, with the subscapularis tendon.

A broad interval naturally exists between the two tendons last named, through which displacement into the axilla must always occur.

Accessory, or Coraco-humeral Ligament.—A dense band of fibres arising from the inferior and anterior part of the coracoid process, and passing downwards and outwards, expanding as it descends, becomes blended and lost in the capsule, of which it is truly a part, immediately above the great tuberosity of the humerus. Its use it to limit over-extension of the arm, as well as rotation outwards.

Glenoid Ligament.—Proper to the scapula itself, round the edge of the glenoid cavity of which it is attached; if cut across, the section is triangular, with the base attached, and the apex free. It consists of a series of fibres irregularly disposed, and decussating with each other very obliquely; and, while it deepens the recipient cavity to the extent of about a quarter of an inch, it alters its shape from an ovoid, which it exhibits in the dry condition, to a short oval. Apparently of little use as a protection against dislocation, it is of marked advantage in forming a cushion for the head of the humerus, in order to preserve it from the injuries to which it would be liable by being suddenly brought in contact with the sharp edges of the glenoid cavity, during the numerous and free motions with which this joint has been endowed. It is very generally believed, that this ligament is formed by the long tendon of the biceps, which, arising from the apex of the cavity, bifurcates, and thus encloses it.

Interarticular Ligament.—By some authorities, this has been said to be formed by the tendon of the biceps, which traverses the articulation immediately beneath the capsule, and in support of this view cases have been cited where it has been found to have been inserted into the upper part of the bicipital groove between the tuberosities, and from thence to have proceeded downwards as if from a new point of origin to its ultimate insertion. This, as a normal condition of the muscle, we have never had an opportunity of witnessing, after repeated examinations; but we have in several instances observed a complete deficiency of the tendon of the biceps from the upper part of the glenoid cavity as far as the tuberosities of the humerus; in all those cases it was evidently the result of arthritic disease. The interarticular ligament, more properly speaking, is that peculiar structure described by the late Dr. Flood of the Richmond, now the Carmichael, School of Medicine, and may be exposed by throwing the arm upwards, and dividing the capsule in its inferior part, when a fold of synovial membrane will then be observed, enclosing a little fibrous tissue stretching from the inner side of the glenoid cavity, just where it is crossed by the tendon of the subscapularis, outwards and forwards, to be implanted into the

upper part of the bicipital groove. This process is bifid at both its extremities; but it is very variable in the appearance which it may present, being sometimes exceedingly well marked, while in other instances it is so indistinct in its character that it can scarcely be satisfactorily demonstrated.

SYNOVIAL MEMBRANE, is very extensive, as, in addition to its actual inflection within the joint, it likewise sends processes beyond it, as for example those to the bursæ of the infraspinatus and sub-scapularis, to which we have already alluded; and, in addition to these, a large process is also folded around the tendon of the biceps, which it accompanies for some distance, when it is again folded back, to become continuous with the general sac.

MOTIONS.—Very extensive, consisting of flexion, extension, ab-duction, adduction, circumduction, and rotation.

Flexion, or the motion forwards, can be carried to a great extent,—even so far that the humerus may be elevated vertically in a direction exactly opposite to the position it occupies in its quiescent state. This mobility is due in some degree to that of the scapula, which revolves on its imaginary axis in unison with the humerus, and is limited only by its neck coming in contact with the triangu-lar ligament. *Extension*, however, cannot be carried so far as the preceding, as it is checked by the teneness of the accessory ligament and the tendons surrounding the articulation. *Abduction*, on the other hand, is remarkable for the great extent of freedom that it enjoys, as in this motion the head of the humerus leaves the gle-noid cavity, and can be distinctly felt in the axilla, being kept in this position by the capsule alone. *Adduction*, again, is exceedingly trifling, the contact of the arm with the trunk presenting an effectual barrier to it. *Circumduction* is very perfect, the head of the bone representing the point of the cone, and the revolution of its inferior extremity, on the other hand, forming its base. *Rotation* exists to a moderate degree, the motion being principally produced by those muscles which are inserted into its neck, at a right angle to its shaft.

HUMERO-CUBITAL ARTICULATION.

Is formed by the union of three bones, the humerus, ulna, and radius, the articulation of the two former bones, if taken separately, constituting a complete ginglymoid joint; but as the radius likewise enters into its formation, and enjoys more unlimited motion than that of flexion and extension, forming, in fact, an arthrodial joint with the humerus, it will be necessary to class the elbow under the designation of an arthrodial ginglymus. Its media of connexion are an anterior and a posterior, an internal and external lateral

ligament; and in order to obtain a good view of these, all the muscles about the joint should be removed, but with great caution, as several of them are intimately attached to them.

Anterior Ligament.—Is thin, but possessed of a moderate degree of strength; arises by a series of fibres from the space immediately above the depression on the anterior surface of the humerus, particularly towards the internal condyle, and, passing obliquely downwards and outwards, is inserted into the coronoid process of the ulna, becoming blended at this point with the attachment of the orbicular ligament; in addition to its vertical fibres, we likewise find transverse ones, which crossing it nearly at right angles, add considerably to its strength; it is covered by the brachialis anticus, which lies immediately over it.

Posterior Ligament, as contrasted with the preceding, is very weak and lax, being attached to the humerus above the olecranoid depression, as far out as the back part of both condyles; from this it sweeps across the joint, and is inserted by a few scattered fibres into the upper edge of the olecranon process. The tenuity and looseness of its structure are so obvious, that its use as a ligament may be fairly questioned, and it should be more properly regarded as a kind of protection to the synovial membrane against the pressure of the tendon of the triceps, which lies directly over it.

Internal Lateral Ligament.—Possessed of great strength, and triangular in shape; may be said, strictly speaking, to consist of two distinct fasciculi, continuous at their apex, but divergent at their base, and bound together by a powerful transverse band, strong and well-marked below, but gradually becoming weaker as it ascends. The anterior slip arises from the internal condyle, and, passing nearly vertically downwards, is inserted into the inner side of the coronoid process, where it affords a point of origin to the flexor sublimis; while the posterior, arising in common with the preceding, but directed downwards and backwards, is implanted into the inner side of the olecranon, where it gives attachment to some fibres of the triceps. The transverse band particularly alluded to by Sir A. Cooper not only connects the two slips to each other, but is attached below to the lip of the sigmoid notch of the ulna, and is here dense and well marked, but as it passes upwards towards the internal condyle, it gradually becomes weaker and less ligamentous in its character.

External Lateral Ligament.—Inferior in strength to the preceding, but is of the same triangular shape; arises from the external condyle by a narrow, pointed extremity, and from this descending nearly vertically, and becoming gradually broader, is inserted into the orbicular ligament of the radius, and by a few scattered fibres

into the outer and anterior surface of the coronoid process. It is concealed and strengthened by the supinator brevis, which adheres to it very intimately.

Synovial Membrane, is common to this as well as to the radio-ulnar articulation, and it must therefore be necessarily extensive; it is especially lax posteriorly, where it is blended with a little adipose tissue, and prolonged for some distance upwards between the triceps and bone.

Motions.—*Flexion* and *extension* only. In the first of these movements the fore-arm can be bent on the arm, until the coronoid process strikes against the fossa for its reception on the front of the humerus, but beyond this it cannot be carried. In this condition of extreme flexion the triceps and posterior ligament are on the stretch, while the hand, from the twisting inwards of the lower extremity of the humerus and obliquity of the trochlea, is directed towards the mouth. Extension is the opposite of the preceding, but it is much more circumscribed, as it is checked the moment the arm and fore-arm form a continued straight line, by the olecranon process striking against its recipient cavity posteriorly, and the ligaments and muscles on the front of the joint becoming tense. The rapidity of these motions is very remarkable, depending upon an admirable contrivance of nature, by which strength, which is here not so much required, has been sacrificed to insure celerity; the tendons which act upon the joint being inserted so close to the centre of motion that a length of radius is thus obtained, the extremity of which, the hand, moves swiftly through its arc of a circle, with a very trifling contraction of the muscles which constitute the moving power.

RADIO-ULNAR ARTICULATION.

Is a double lateral ginglymus, the two bones constituting it being in contact laterally, but at two distinct points, viz., above, where the radius is received into a depression in the ulna; and below, where the ulna is in turn received by the radius: they are united superiorly by the orbicular and oblique ligaments, in the middle by the interosseous, and inferiorly by an anterior and posterior with the inter-articular fibro-cartilage.

Orbicular Ligament.—Is a flattened band of fibres, about a quarter of an inch deep, exceedingly strong, especially posteriorly, and forming about three-fourths of a circle; its two extremities are attached to the anterior and posterior edges of the lesser sigmoid notch, thus completing the ring for the reception of the rim which surrounds the head of the radius; while its inferior margin forms the segment of a circle smaller than that of the superior, an arrange-

ment which has a manifest tendency to add to the security of the articulation. It is covered in front and externally, by the supinator brevis, which is intimately attached to it, and behind by the anconeus.

Synovial Membrane.—Is a process extending as a *cul de sac* from that of the elbow-joint.

Oblique Ligament.—Is thin but strong, arising from the shaft of the ulna, immediately below the coronoid process, from which it passes downwards and outwards, to be inserted into the anterior surface of the radius, below its tuberosity. It lies between the supinator brevis, and flexor sublimis, and is rendered tense by supination, while pronation relaxes it.

Interosseous Membrane.—Is like that between the tibia and fibula, extremely strong, consisting of a series of fibres, stretching downwards and inwards, from the inner edge of the radius to the outer of the ulna, and intersected by a few others which take a contrary direction. It is deficient both above and below, for the passage of the interosseous vessels and nerves, while it affords attachment by its anterior surface to the flexor profundus, and pollicis, and by its posterior to the extensors of the thumb. This ligament, like the preceding, is relaxed in pronation, and rendered tense by supination.

Inferior Radio-ulnar Ligaments.—Consist of a series of weak fibres, extending nearly transversely across, from the anterior and posterior surfaces of the ulna to the corresponding ones of the radius. They are sufficiently lax to allow of the necessary degree of mobility in the articulation, and are concealed by the flexor tendons in front, and the extensor behind.

Interarticular Fibro-cartilage.—Is triangular in shape, and very thick at its apex and margins, but thin at its base and in its centre; it is attached by its apex internally to the depression between the head and styloid process of the ulna, and passing beneath the former it is inserted by its base into the internal margin of the articular groove on the inner side of the radius, forming from its attachments and position not only a bond of union between the bones of the fore-arm, without in the slightest degree interfering with their peculiar motion, but likewise assisting in completing the cavity for the reception of the bones of the carpus.

Synovial Membrane.—Is peculiar to this articulation, but from the manner in which it is invested by fibrous tissue, and prolonged upwards between the radius and ulna, it has received the designation of the sacciform ligament, which is attached internally to the styloid process of the ulna, and externally to the articular surface of the radius.

Motions.—Pronation, and supination.

Pronation.—This motion is much more extensive than supination,

and can be carried so far that the radius may lie across the ulna at a very oblique angle, the curvature in the former bone adding materially to its freedom of mobility in this direction. In this movement the ulna is invariably fixed, and the head of the radius rotates in the lesser sigmoid notch, while its inferior extremity, gliding forwards on the rounded head of the ulna, performs in fact a motion of semicircumduction, which is only limited by the bones coming into actual contact, as they cross each other. In *supination*, on the contrary, the head of the radius still rotating in its osteo-fibrous ring, its inferior extremity is carried backwards, but by no means to the same extent as is observed in the pronation, for here both the interosseous and oblique ligaments becoming decidedly tense, altogether prevent the motion of supination from proceeding beyond a certain point. Force suddenly applied to the hand, when in a condition of either forced pronation or supination, is very liable to produce displacement of the head of the radius, either backwards or forwards, but the former is always the more likely to occur owing to certain anatomical reasons.

RADIO-ULNAR ARTICULATION WITH WRIST.

Is an arthrodial joint; or, as some term it, a condylarthrosis. A cavity is formed above by the inferior extremity of the radius and triangular fibro-cartilage, with the styloid processes of the radius and ulna bounding it on either side, which receives a convexity, composed of the scaphoid, lunar, and cuneiform bones, the security of the joint being insured by an internal, external, anterior, and a posterior ligament.

External Lateral.—Is exceedingly strong, taking an origin narrow from the point of the styloid process of the radius, and passing downwards, gradually increasing in breadth, is inserted into the outer side of the scaphoid bone, and sometimes by a prolongation into the trapezium.

Internal Lateral.—Is weaker than the preceding, and consists usually of two fasciculi, both of which are attached, above to the point of the styloid process of the ulna, from which they descend to be inserted into the pisiform and cuneiform bones. Both slips are, however, occasionally completely blended together.

Anterior, and Posterior Ligaments.—Are broad but weak and lax, especially the latter. They take their origin from the anterior and posterior edges of the radius, and pass downwards and inwards, and are inserted into the corresponding surfaces of the first row of carpal bones, except the pisiform. There are two distinct processes of the anterior, which, while they are implanted into the semilunar

bone by a simple attachment, are bifid where they spring from the radius; a similar arrangement is met with in the posterior, but it requires a closer examination to detect it; the division between the two portions being visible both at the points of origin and insertion.

This articulation, like the ankle-joint, is provided with annular ligaments, to confine the several tendons, which play around it in their position. They are two in number—an anterior, which is short, thick, and exceedingly strong, stretching between the scaphoid and trapezium externally, and the unciform and pisiform internally, continuous with the fascia of the arm superiorly, and with the palmar aponeurosis inferiorly; and a posterior, much thinner and weaker, but longer, extending from the styloid process of the radius externally to the styloid process of the ulna, and pisiform bone, internally; being continuous, above and below, with the fascia of the fore-arm and back of the hand. Processes, prolonged from the deep surface of the ligament to the bones beneath, form a series of distinct channels, lined by synovial bursæ, for the passage of the several extensor tendons. These channels are six in number; the four external, being in the radius; the fifth, between that bone, and the ulna; and the sixth, in the ulna itself. In the first of these, commencing from the outside, are the tendons of the extensor ossis metacarpi and primi internodii pollicis; in the second, which is always broad and occasionally double, are the two radial extensors; in the third, which is very narrow and oblique, the extensor secundi internodii pollicis; in the fourth, the extensor communis, and indicis; in the fifth, between radius and ulna, extensor minimi digiti; and in the sixth, the ulnar extensor. Beneath the anterior ligament, there are only two grooves, of which the more internal is for the flexor communis, and profundus; and the more external for the flexor pollicis longus, while it is crossed by the palmaris longus, and flexor carpi ulnaris, the superficialis volæ and ulnar arteries, the ulnar and superficial palmar nerves, and perforated by the tendon of the flexor radialis.

Motions.—Flexion, extension, abduction, adduction, and circumduction. In the two first of these motions the hand can be brought nearly to a right angle with the fore-arm, and is limited by the tension of the ligaments before and behind, and of the tendons which cover them. The range of abduction is very trifling, from the styloid process of the radius, and scaphoid coming in contact almost immediately; but adduction is less circumscribed, from the interval which naturally exists between the lower part of the ulna and its corresponding carpal bone; while circumduction is nothing more than a rapid alternation from one to the other of all the preceding motions.

CARPAL ARTICULATION.

This is constituted by the eight bones of the carpus, forming a series of articulations, severally and collectively, one with the other; and as nature has arranged them in two rows we will adopt the same plan, by first explaining the connexion between the bones of each tier, and then describing the union between tier and tier.

The carpal bones of the first row are in contact with each other by extremely small facettes; while those of the second are much larger; but they are all connected by anterior, posterior, and interosseous ligaments. Of these the two first are narrow slips, extending from bone to bone in front and behind, the anterior being much the stronger of the two, while the interosseous are thick but short bundles, stretching between the non-articular adjacent surfaces, and possessed of an amount of strength, amply sufficient in themselves to insure the integrity of the whole. To this rule the pisiform bone is, however, an exception, as it is isolated, and forms a distinct joint with the cuneiform, to which it is united by an imperfect capsular ligament, that extends downwards as far as the unciform, and to the base of the fifth metacarpal bone. Generally it has also a separate synovial capsule, although it is sometimes continuous with the radio-carpal.

The several bones being connected together in the manner just described; the two rows which they constitute are again united to each other in the following manner:—The prominent head of the os magnum is received into a socket formed by the scaphoid and semilunar, while internally the cuneiform dips down to articulate with the unciform, and externally the scaphoid is prolonged in the same direction to meet the trapezium and trapezoid. The os magnum is retained in its position by a strong anterior ligament, and a posterior which is much weaker; the former is always well marked, and consists of a vertical set of fibres, which arise by a single process from the neck of the os magnum, and pass upwards, diverging so as to be inserted by three slips into the anterior surfaces of the scaphoid, semilunar, and cuneiform; these again being crossed by a series of transverse fibres, extending between the unciform bone on the inside, and the trapezoid on the outside. The posterior ligament is not so well marked; its fibres decussate with each other over the posterior part of the head of the os magnum, dipping down to be attached to its neck, and terminating by being inserted into the adjacent bones of the first row. The union of the scaphoid with the trapezium, and trapezoid is completed by anterior and posterior ligaments, consisting of two slips before and behind, stretching from the bone above to the two below, the posterior being much the thinner and weaker. In

addition to the ligaments just described as connecting the preceding bones, the cuneiform, and unciform have likewise, each, an internal lateral, which is rounded and strong.

Synovial Membrane.—This forms one large sac common to all the articulations.

CARPO-METACARPAL ARTICULATION.

The First Metacarpal bone, or that of the thumb, articulates with one bone only,—the trapezium,—the surfaces of both being alternately concave and convex, forming a joint by mutual reception; it has only one ligament,—a capsular, which is loose, and very strong posteriorly, but weaker and thinner in all other directions; its synovial membrane is separate and distinct, while its motions are very extensive, having them all exceedingly well marked, except rotation.

Second Metacarpal.—Articulates with three carpal bones,—the trapezium, the trapezoid, and the os magnum, to which it is connected by dorsal and palmar ligaments; the former consisting of three,—an external, from the trapezium; a middle, from the trapezoid; and an internal, from the os magnum; all being inserted into the posterior surface of the metacarpal bone; while the palmar, thin and weak, extends from the trapezoid only to the anterior face of the metacarpal bone.

Third Metacarpal.—Is united to one carpal bone only—the os magnum, to which it is connected by two dorsal, and three palmar ligaments; the former, arising from the os magnum, and unciform, pass forwards, converging towards each other, to be inserted into the posterior surface of the metacarpal bone; while the palmar, taking their origin from the trapezium externally, the os magnum in the middle, and the unciform internally, gradually converge, and are implanted into the anterior face of the metacarpal bone.

Fourth Metacarpal.—Articulates with the os magnum, and unciform, having only one dorsal, and one palmar ligament, which spring from the anterior, and posterior aspects of the bones alluded to, and stretch to the corresponding surfaces of the head of the metacarpal bone.

Fifth Metacarpal.—Is united to the unciform bone only, having three ligaments for its security—an anterior, a posterior, and an internal; they pass from one bone to the other in the courses indicated by their names, and firmly connect them both together.

Synovial Membrane.—There are three distinct processes, for the carpo-metacarpal articulation; the first has been already alluded to as being peculiar to the thumb; but the second, and third, which are prolongations from that of the carpus, are supplied, the one to the

second, and third metacarpal bones, and the other to the fourth, and fifth.

UNION OF THE METACARPAL BONES WITH EACH OTHER.

They are united both at their carpal and digital extremities, presenting in the first instance small lateral facettes, which are in contact with each other, and are secured by dorsal, palmar, and interosseous ligaments ; the two first of these consisting of thick fasciculi of fibres, stretching from the head of one metacarpal bone to that of the next, the palmar being much the stronger ; while the interosseous occupy the intervals between the facettes, and are possessed of very great strength.

The digital extremities do not, strictly speaking, articulate with each other, a small synovial sac being interposed between each, to facilitate their motions ; they are united together by a loose transverse ligament, which stretches between them on their anterior surface, and thus prevents their divarication ; this band of fibres does not, however, include the metacarpal bone of the thumb.

UNION OF THE METACARPAL BONES WITH THE PHALANGES.

These are a series of condyloid joints, formed by the union of the heads of the metacarpal bones, which are comparatively large, with the smaller cups presented by the extremities of the first phalanges ; their media of connexion being an anterior, and a posterior, an internal, and external lateral ligament.

Anterior Ligament.—Is dense and strong, attached above to the constricted neck of the metacarpal bone, and below to the anterior surface of the corresponding phalanx, where it becomes continuous, by a thin aponeurosis, with the lateral ligaments ; it is grooved, and corresponds anteriorly to the flexor tendons, while it is concave posteriorly to accommodate the ends of the adjacent bones.

Posterior Ligament.—Thin, and occasionally scarcely capable of demonstration ; it merely passes from the upper surface of one bone to the other, and is covered by the extensor tendons.

External, and Internal Lateral Ligaments.—Are thick, strong slips, pointed posteriorly, where they are attached to the tubercles on the sides of the metacarpal bone, but broader and thinner anteriorly, where they are inserted into the tubercles on the lateral surfaces of the first phalanx, while their margins become blended with the dorsal, and palmar ligaments ; two sesamoid bones are found on each side in the articulation of the thumb, and into these the tendons of its small muscles are inserted.

Synovial Membrane.—Is very lax, especially posteriorly, where it is required to be folded out in motions of flexion.

PHALANGEAL ARTICULATIONS.

These, like the preceding, are condyloid, and have precisely similar ligaments; it would, therefore, be a needless repetition to reiterate them here.

The hand, constituted in the manner just described, is essentially an organ of prehension, and its basis or foundation—the carpus, is remarkable for its strength, depending as well on the manner in which its bones are accurately dovetailed together, as on the number of its ligaments; the union between it and the metacarpus permits but very limited motion, except in the instance of the thumb, where great mobility is requisite, as it is the organ which is continually brought into action to oppose the prehensile functions of all the others. In the mechanism of the phalangeal portion we find vast strength combined with great delicacy of touch, forming the appropriate termination to one of the most exquisite pieces of workmanship that the mind can conceive—the human hand.

TEMPORO-MAXILLARY ARTICULATION.

Is formed by the condyle of the inferior maxillary bone being fitted or received into the glenoid cavity of the temporal; the articulation is condyloid, and it has for its security an external, an internal, and a capsular ligament, with an interarticular fibro-cartilage.

External Lateral.—Is a short, thick ligament, arising from the tubercle at the bifurcation of the zygomatic arch, and passing downwards and backwards, is inserted into the outer side of the neck of the lower jaw; it rests by its deep surface on the joint, and is covered superficially by the skin and fascia.

Internal Lateral.—Is long, thin, and weak; attached above to the spine of the sphenoid bone, and below to the lip or spur on the edge of the dental foramen, from which it sends downwards and forwards over the mylo-hyoid nerve a prolongation which afterwards becomes continuous with the periosteum. It is in relation externally with the internal maxillary, dental, and middle meningeal arteries; gustatory, dental, temporo-auricular, and Vidian nerves; and with a thin process of the parotid gland—all separating it from the vertical ramus of the inferior maxilla; internally it corresponds to the internal pterygoid below, and to the levator palati, and Eustachian tube above. Great diversity of opinion exists as to the use of this ligament; it can scarcely, as is commonly said, be of any service in

protecting the vessels and nerves from being compressed against the jaw by the action of the internal pterygoid, as in the first place it is too weak and too lax to effect that purpose, and secondly the very contraction of the muscle naturally argues a relaxed condition of the ligament; neither can it be believed, as is asserted by others, that it is placed there solely for the purpose of conducting the middle meningeal artery to its destination. But it might, during fœtal life, when the jaw consisted of two distinct pieces, have formed in conjunction with the external, a species of sling for the support of each lateral half, and thus tended to keep the condyle in proper apposition with the glenoid cavity.

Capsular Ligament.—Is barrel-shaped and loose, in order to permit the free motion of the jaw; it is attached above, in the following manner—anteriorly, to the transverse root of the zygoma; externally, to its horizontal; posteriorly, to the Glaserian fissure; and internally, to the roots of the spinous and styloid processes of the sphenoid bone; while below, it encircles the neck of the jaw, which it closely embraces; its degree of strength is very variable, being very strong and dense anteriorly, and externally, but much weaker and thinner, internally and posteriorly, while it is perforated in front and on its inner side by the external pterygoid, as it passes to its insertion into the interarticular fibro-cartilage.

Interarticular Fibro-cartilage.—Is oval in shape and remarkably thick at the edges, but extremely thin, often perforated in the centre; its upper surface is concavo-convex—concave anteriorly, where it rests on the transverse root of the zygoma; but convex posteriorly, where it corresponds to, and fills up the glenoid cavity; its inferior surface is deeply concave, and moulded on the upper part of the condyle, to which it is closely united by the reflection of the inferior sac of the synovial membrane, strengthened by a little scattered fibrous tissue; this, as well as the attachment of the external pterygoid muscle, insures its following the condyle in all its motions, thus forming a temporary socket for it, and guarding it against the displacement to which it would be, otherwise, liable, from the action of the powerful muscles which are connected to it.

Synovial Membrane.—Generally speaking, consists of two distinct processes, separated from each other by the cartilages; the superior is remarkable for its laxity, and the inferior for its tensity; they occasionally communicate through the foramen in the cartilage.

Motions.—Downwards, upwards, gliding, and lateral. In the first of those motions, which is effected by the contraction of the muscles attached from the os hyoides to the jaw, the condyle, with the interarticular cartilage, glides forwards on the transverse root of the zygoma, and, should the motion be carried too far, may slip anterior

to it into the zygomatic fossa, but the occurrence of this accident is usually prevented by the extremely tense condition of the posterior fibres of the temporal, and masseter, the external lateral ligament and anterior part of the capsular being likewise on the stretch; the upward motion, which is accomplished by the muscles of mastication, is limited effectually by its contact with the upper jaw, while here the condyle and cartilage, favoured by the natural inclination, pass backward into the glenoid cavity, their natural position, and press firmly against the posterior part of the capsule; in this condition, while the mouth is nearly closed, the gliding motion forwards and backwards is most apparent,—the one being effected by the contraction of the external pterygoid and anterior fibres of the masseter, while it is restored again to its normal position by the posterior fibres of the latter muscle, aided by the same portion of the temporal. In the lateral motion, the condyle of one side advances on the transverse root of the zygoma, whilst the other presses against the capsule posteriorly; it is accomplished principally by the external pterygoid aided by the posterior fibres of the masseter of the corresponding side being called into action, while that of the other may either remain quiescent, or act in opposition to it.

We may here cursorily allude to the stylo-maxillary and intermaxillary ligaments, the former being merely a process of the deep cervical fascia, stretching between the upper and outer edge of the styloid process of the temporal bone, and the angle of the lower jaw. It is strong and well defined, and serves in some measure to limit the lateral motion of the articulation. It lies between the parotid and submaxillary glands, and separates the facial from the external carotid artery.

Intermaxillary Ligament, extends between the hamular process of the internal pterygoid plate, and the root of the coronoid process of the inferior maxilla, being merely a strong process of the pharyngeal aponeurosis, giving origin to the superior constrictor posteriorly, and the buccinator anteriorly.

SECTION III.

MUSCULAR SYSTEM.

Muscles constituting the active agents of locomotion are stretched between and surround the several bones in the extremities, while they also more or less completely envelope cavities for the purpose of producing the requisite change in the inclosed organs by their

contractions; or, by investing the hollow viscera themselves, may urge their contents towards their natural outlets.

A muscle is an aggregation of a peculiar fibrous element united by areolar tissue, and usually (at least in one class) presents at either extremity, a tendon, or an expanded aponeurosis, by which it is connected to the bones. In their vital properties muscles exhibit contractility and sensibility, and, in their physical, elasticity, resistance, and pliability; the colour may be red, or pale; and the shape display an infinite variety, as they may be thick, round, or fusiform; flat and expanded, or penniform, or bipenniform in the arrangement of their fibres. Their nomenclature is derived, first, from their position, as brachialis anticus; secondly, from direction, as obliquus externus, rectus, &c.; thirdly, from shape, as rhomboideus, scalenus; fourthly, from action, as pronator teres, supinator longus; fifthly, from structure, as digastric; and, lastly, from attachment, as the sterno-hyoid, and thyroid.

The muscular system is divided into the animal, or voluntary, or striped; and into the organic, or involuntary, or unstriped; the former being usually arranged in a thick, round mass, of a deep red colour; having tendon in its composition, with bony attachments placed external to the skeleton, while it is also voluntary in action, supplied by the cerebro-spinal system of nerves, and composed of fibres visibly striped in a transverse direction. The organic, on the other hand, is thin and pale, surrounds internal viscera, is destitute of tendon or bony attachment, is involuntary, supplied by the sympathetic system of nerves, and the fibre is unstriped, the contractions being slow and rhythmical. Still exceptions to those rules will be found; as, for instance, the heart, although an organic muscle, is red, thick, and strong, with the fibres presenting a faint striation; and again, we are coerced by their very properties to recognise a third class of muscles, which are of a mixed character, as, for example, the diaphragm, sphincters, and œsophagus.

Structure of Muscle.—It consists of fibres varying in size and irregular in shape, but generally angular in figure, each being surrounded by a proper sheath, called sarcolemma. This fibre, when examined with a power of 450 diameters, presents a number of transverse, equidistant, dark lines or stripes, with fainter longitudinal markings, which are by no means constant or regular in their appearance, the spaces intervening between the stripes being longer than broad when the fibre is quiescent, but exactly the reverse when contracted. If this fibre is torn transversely, a disc is the result, but if longitudinally, a fibrilla (Bowman). The fibrilla is remarkably fine, without branches, and consists of a series of cells, which, by their edges being opposed, produce the striæ (Sharpey, Carpenter);

or of a number of particles opposed by their extremities, constituting sarcous elements, the animal contents being termed sarcine (Bowman); or of fibrillæ, themselves simply constituting the fibre (Fontana, Hassal). The organic muscular fibre smaller than the voluntary, flattened, and without transverse markings, contains numerous nuclei imbedded in its tissue, indicative of the primary development from nucleated cells, their diameter varying from the 1–2000th to the 1–3000th of an inch. The tendons of muscles are composed of white fibrous tissue; the sarcolemma of the fibres being continuous with them, and each fibre terminating individually either in or on their extremities.

Muscles are the active agents of the economy,—contractility, or the generation of power, being the inherent attribute of the fibre,—the force of any given muscle being exactly in proportion to the quantity of fibres that it contains. The fibres, in sustained action, diminish one-third of their original length, but where a limited extent of motion is requisite, and where energy and power are also of importance, the fibres are augmented, with diminished extent of action, by a penniform arrangement, as in the rectus femoris. The causes assigned as the source of contraction are numerous, volition being obviously the natural excitor of the action; but, although the effects are visible, the immediate cause is exceedingly obscure. A muscle is observed during contraction to become shorter, thicker, and harder, with an increase of temperature; such a condition being easily excited in muscles laid bare and subjected to galvanism. The whole muscle is not thrown at once into a state of contraction, but the power producing it radiates from the stimulated point, until it equally pervades the entire fibres. As to the immediate causes of contraction, Prevost and Dumas conceived that the nervous filaments were distributed to the fibres at angles, and that, being dissimilarly electric, they attracted each other, thus producing the zig-zag condition observed so frequently; but this appearance is nothing more than merely the result of the shortening of the neighbouring fibres. It has also been attributed to the sudden influx of a large quantity of blood into the vessels of the muscle; while precisely the contrary opinion has likewise been maintained,—that the escape of the blood was the excitor of contraction. Haller conceived it to be a power inherent in the fibre itself; Skey imagined that it depended on the shortening of a spiral cord that surrounded it, while others have argued that it is due to contraction of the transverse stripes, and to alteration in the sarcous elements; but these, either individually or collectively, are wholly inadequate to account for the great functional activity so constantly in operation. In the voluntary muscles the contractions are energetic, but of short duration, while in the invol-

untary, on the contrary, they are less energetic, but more prolonged. Muscles act on bones as the moving power, and thus represent levers, of which the three following orders exist:—the first, with the power at one extremity, the weight at the opposite, and the fulcrum or fixed point occupying an intermediate position, as for example in the nodding motions of the head, and in extension of the forearm by the triceps muscle. The second order, has the weight in the middle, with the power at one extremity, and the fulcrum or fixed point at the opposite; this has been termed the crushing lever, the action of the gastrocnemius during progression, affording an excellent example of this class. The third order, has the fulcrum at one extremity, the weight at the other, and the power at any intermediate point between them. This form of lever is the one that is the most generally found in the body, as by its adoption rapidity of motion, and symmetry of form are obtained to a very great extent, but power is sacrificed in the same proportion. The power of individual muscles may be much diminished, owing to certain mechanical circumstances—as, for instance, their insertions being at acute angles to the lever on which they act; the obliquity of direction, acting through a disadvantageous lever; and the passive contraction of opposite muscles. The masseter, and gastrocnemii, are from the mode of their insertion, instances of the most powerful muscles in the body, from their fibres forming right angles with the lever into which they are inserted. Muscles are also highly organized, the arteries running in the interfibrous spaces, while the nerves too are numerous; and thus it may be stated as a general rule, that the greater the amount of vascular and nervous supply, the more energetic are the contractions of the muscle; this rule being fully borne out in certain pathological conditions, in which nutrition is diminished; as, where the arteries are ossified, or partially obliterated, the contractions are always found to be feeble and weak.

MUSCLES OF THE HEAD AND FACE.

Raise the subject by a block placed beneath the shoulders, and support the head in a nearly vertical condition, when several different modes of incision may be adopted with almost equal advantage, for the purpose of removing the integument. In making post-mortem examinations, where it is an object to avoid disfiguring the features with blood, a transverse incision from ear to ear, with the subsequent reflection of the flaps, will be found most advantageous; but for anatomical purposes it will be preferable to run a circular incision around the scalp; in front, above the superciliary arches; laterally above the ear; and posteriorly, above the occipital protuberance:

when an antero-posterior incision from the last-named point to the root of the nose, will further facilitate the raising of the integument. This should be accomplished cautiously, commencing before and behind, as it adheres loosely to the muscular fibres, but closely to the subjacent tendons; and, having succeeded in raising it, the several constituents which compose it should first be examined. The cuticle, thick and laminated, adheres intimately to the cutis, in consequence of the number of prolongations that are sent into the hair-follicles, which accounts for the difficulty experienced in producing vesications on the scalp, while the cutis is dense, and the fibrous arrangement of its structure can be well observed in this section, the hair-bulbs variegating the surface, and tending to increase the density of the tissue. The deep aspect is rough, and attached to the subjacent muscles and tendons, by dense areolar tissue, an arrangement which constrains the integument to follow the muscle in all its varied contractions.

Occipito-frontalis covers the anterior, middle, and posterior regions of the cranium, and while thin and weak in some subjects, is thick and well-marked in others. It consists of two fleshy portions behind (occipital), and the same in front (frontal), with an intervening tendinous expansion (epicranial aponeurosis), and hence it has been termed a quadriceps muscle. The posterior portion arises on either side by short tendinous fibres from the two external thirds of the superior curved line on the occipital bone, also from the outer and back part of the mastoid process; from those points it passes upwards and inwards over the occipital bone, and is inserted into the posterior edge of the aponeurosis; while the anterior fleshy portion, also double, but not so strong as the former, arises from the anterior edge of the aponeurosis by a lunated border; and proceeding downwards and forwards over the frontal bone, is inserted into the eyebrow, mixing with the fibres of the orbicularis palpebrarum; while a few of its internal fibres, are implanted into the internal angular process of the os frontis, there becoming continuous with the long head of the levator labii superioris alæque nasi, and a few more form two flat bands, called the pyramidales nasi, which descend on the dorsum of the nose, and become blended with the aponeurosis of the compressor nasi.

Epicranial Aponeurosis, is a thin sheet of dense fibrous tissue, wider behind than before, but narrower in the middle than at either extremity; laterally it is attached to the temporal ridges, where it sends a thin process over that fascia, while both anteriorly and posteriorly, the fleshy bellies of the occipito-frontalis are attached to it, but it sends down a process between its two posterior fleshy bellies to be attached to the occipital protuberance. The superficial surface

is connected to the integument by dense areolar tissue, while the deep is free, and extremely movable on the bone, owing to the fine lax areolar tissue immediately beneath it.

Relations.—This muscle lies on the occipital, parietal, and frontal bones, and on the dorsum of the nose; a thin layer also rests on the temporal fascia. It is covered by the integument, and by areolar tissue through which ramify the following vessels, and nerves:—anteriorly, the supra-orbital artery and nerve, with the supratrochleator nerve, and frontal artery; laterally, the temporal artery, and four nerves, viz., auricularis magnus, temporo-auricular, temporal branch of superior maxillary, and lastly, temporal branches of the portio dura; posteriorly, the posterior auris artery and occipital, with the posterior auricular the lesser occipital, and great occipital nerves.

The Muscles of the external ear, seen by raising the fine integument which covers the auricle, are large and well marked in the lower animals, but merely rudimentary in man. The division, into a common and proper set, is that usually adopted,—the former being three, and the latter five, in number.

Common Muscles are the attrahens, attollens, and retrahens aurem.

Attrahens Aurem, weak and indistinct, arises from the temporal fascia and epicranial layer, and, passing backwards, is inserted into the descending portion of the helix. *Relations.*—It lies on the temporal fascia and vessels, and epicranial layer, and is covered by the integuments and superficial fascia. *Action.*—To draw forwards the helix, and thus dilate the concha.

Attollens Aurem, triangular in shape, arises broad and expanded from the epicranial aponeurosis and temporal fascia, and passing downwards,—the fibres, converging as they descend,—is inserted into the upper part of the concha. *Relations.*—It lies on the temporal and epicranial aponeurosis, and is covered by the integuments, being sometimes united by its anterior margin with the attollens aurem. *Action.*—To elevate the whole auricle, and dilate the concha.

Retrahens Aurem, the strongest of the three muscles, arises double, sometimes by three portions, from the base of the mastoid process, and, passing forwards, is inserted tendinous into the posterior part of the concha.

Relations.—It lies on the bone and posterior auris artery, and is covered by the skin, while a branch of the posterior auricular nerve enters it. *Action.*—To retract the whole auricle, and assist the other muscles in dilating the concha.

The Proper Muscles of the ear are,—the helicis major, and minor, the tragicus, anti-tragicus, and tranverso-helicis; they are

seeu by removiug the fine integument cautiously from the concave surface of the auricle.

Helicis Major.—A flat, oval bundle of fibres, wide and fleshy in the centre, narrow aud tendinous at each extremity, lies immediately beneath the integument, on the superior and descending portions of the helix, above the tragus; is usually about three-quarters of an inch in length.

Helicis Minor.—A flat, tougue-shaped band, lying obliquely on that part of the helix within the concha, for the purpose of drawing inwards the helix, aud thus, by actiug with the last-mentioned muscles, to deepen the cavity of the concha.

Tragicus.—A flat, diamond-shaped baud, but sometimes wantiug; lies on the cutaneous surface of the tragus, without any other attachment.

Anti-tragicus.—Caudate in shape; arises from the cutaneous aspect of the anti-tragus, passes upwards and backwards, and is inserted tendiuous into the commeucement of the concha.

Transversus Helicis.—A semicircular set of trausverse fibres, lying on the mastoid surface of the auricle, passing from the concha to the helix; certainly not muscular, but highly elastic in character.

Before proceeding with the dissectiou of the face, introduce a piece of tow into the anterior nares, and likewise place a portion between the cheek and teeth, so as to render the structures tense in this situation; but it is always preferable to dissect the eyelids without any such preparation, as their margins require at all times to be free, for the proper examinatiou of the appeudages of the organ of vision. The cranium being raised to a conveuieut position, make an incision from the middle liue of the frontal boue, down along the dorsum of the nose, and through both lips, as far as the chin. Carry a second, at first backwards, aud then upwards, aloug the margins of the horizontal and ascending rami of the lower jaw, and then reflect the integument carefully upwards, until the lids are reached; these should be dissected from above, to expose the upper, and from without and below to expose the lower, cutting away the attachments altogether at the margins of the chiasma oculi. It will also be easier to remove the skin from the dorsum of the nose from within, outwards, but this is always most difficult to accomplish on the alæ, owing to its intimate adhesion to the cartilages that bound the anterior nares. The skin is thin on the forehead, but thick on the eye-brow; again thin and fine on the eyelids, but thicker over the masseter, particularly in the male, becoming however finer and more delicate on the cheeks. Over the superior aud inferior labial region, likewise, its structure is remarkably dense in the male, in

consequence of the numerous hair bulbs that stud those parts, while their absence in the female accounts for the extreme fineness usually observed amongst them, at least before the middle periods of life. Beneath the skin, a layer of soft adeps surrounds and connects the muscles, nerves, and vessels of the face, and this is principally seen on the cheeks and superior and inferior labial regions, while on the forehead it is scarcely capable of demonstration, is absent altogether on the lids, and nearly so on the dorsum of the nose. This must be all carefully removed before the deeper structures can be examined with advantage.

The muscles of the face in the majority of subjects are weak, pale, and indistinct, particularly so in the aged, so that in most cases it requires an experienced dissector to exhibit them. They have been divided into a superficial set, or the muscles of expression; and a deep, or muscles of mastication,—the former consisting of thirteen pairs and a single muscle; the latter of five pairs, which are perfectly symmetrical.

SUPERFICIAL MUSCLES.

Orbicularis palpebrarum	Ocular group.
Corrugator supercilii, ...	
Tensor tarsi (Horner), ...	
Pyramidalis nasi, ...	Nasal group.
Compressor nasi, ...	
Levator labii superioris, alæque nasi, . .	Group common to the nose and lips.
Levator labii superioris (proprius), . .	
Depressor labii superioris alæque nasi, .	
Levator anguli oris	Angle of mouth.
Depressor anguli oris	
Zygomaticus major, ...	Oral group.
Zygomaticus minor, ...	
Quadratus menti, ...	Inferior labial group.
Levator labii inferioris	
Orbicularis oris	Proper to Mouth.

Orbicularis Palpebrarum, commonly described as a sphincter muscle, consisting of an upper and lower segment, which, taken conjointly, represent an ellipse, with a tendinous interruption internally, arises from the upper and lower margins of the tendo oculi, from the internal angular process of the os frontis, and from the nasal process of the superior maxillary bone; the segments pass in semicurves outwards, and ultimately meet at the external canthus of the eye, the inferior segment being likewise attached by a few short fibres to the orbital edge of the superior maxillary and malar bones.

Structure and Relations.—It is divided into three portions,—the

orbital, palpebral, and ciliary, each forming concentric curves from within outwards. The orbital fibres are thick, strong, and red, like other animal muscles, and the palpebral thin, pale, and weak, with the physical aspect of the organic sheets of muscular fibre; while the ciliary constitute a thin fasciculus at the margin of either lid, and decussate at their commissures; these also are pale, and very much resemble the tissue of the longitudinal bands of the large intestine.

Relations.—Above, it lies on the corrugator supercilii, supra-orbital nerve, and artery, bone, superior palpebral ligament, with the superior tarsal arch of nerves and arteries; inferiorly, it rests on the bone, the outer head of the levator labii superioris alæque nasi, which separates it from the infra-orbital nerve and artery, on the origin of the great zygomatic and subcutaneous malæ nerve, inferior palpebral ligament, tarsal cartilage, tarsal branch of the superior maxillary nerve, and palpebral artery; internally, on the nasal process of the superior maxillary bone, tendo oculi, lachrymal sac, supra and infra-trochlear nerves, frontal and nasal branches of ophthalmic; it corresponds by its inner margin to the pyramidalis nasi, and outer head of the levator labii superioris alæque nasi, the angular artery separating it from the latter; externally, it lies on the temporal fascia and malar bone, and also on the orbital branch of the superior maxillary nerve, as it pierces the temporal fascia. In addition, the superior margin of the muscle is united to the occipito-frontalis, while the lower part receives the highest fibres of the platysma. It is covered by the skin, areolar tissue, and palpebral branches of the portio dura.

Action.—To close the lids, principally by depressing the upper; it also compresses the lachrymal sac by acting on the tendo oculi, and thus forces the tears into the nasal duct, and from thence into the nose, when it is fully contracted; while extreme tension of the ciliary fibres will turn the internal sixth of the tarsal cartilage backwards, as it is here unsupported, and by this action immerse the punctal orifices in the lake of tears at the inner canthus. When the eyes are closed firmly by a voluntary movement, the orbital fibres are the principal agents, from being quickly obedient to the will; but in those involuntary movements which are continually occurring, the palpebral set are the sole agents, for even during sleep we may frequently see the superior lid in rapid motion, but without the orbital fibres at all participating in the action; and these involuntary movements in some individuals are so frequent and regular, that they might be classed with true rhythmical contractions. Under the microscope, the fibres of the palpebral portion exhibit but faint striæ, and these entirely disappear under the action of acetic acid, forming

a marked contrast to the orbital in this respect; and hence we are disposed to look on the former as exhibiting one of the connecting links between the voluntary and involuntary system of muscles. In old persons the palpebral portions frequently present marked deficiencies between the fibres, thus accounting for the diminished energy of the movements of the eyelids at this period of life.

Now turn downwards, the superior portion of the last muscle, and expose the corrugator supercilii.

Corrugator Supercilii, arises narrow and tendinous, from the internal angular process of the os frontis, and passing obliquely upwards and outwards, is inserted into the deep surface of the orbicularis, and into the integuments of the eyebrow.

Relations.—It is covered by the orbicularis, frontal nerve, and supra-orbital artery, and lies on the bone.

Action.—To throw the forehead into vertical wrinkles, to depress the brows, and, by erecting the hairs, to defend the eye from intense light. Sometimes this muscle is so intimately connected with the orbicularis that it appears to be an additional origin of it, and this fully accounts for the concerted action that is observed so frequently to exist between them.

Tensor Tarsi, (Horner's muscle) is dissected by dividing vertically the upper and lower lid about the centre, and reflecting the internal flaps towards the nose; the conjunctiva should then be raised and the areolar tissue removed, when it will be seen to arise from the crest on the os unguis, behind the lachrymal groove, and passing forwards and outwards, divides into two slips, which are inserted into the lachrymal ducts, being prolonged as far as the puncta.

Relations.—It corresponds anteriorly and internally, to the lachrymal sac and tendo oculi; and externally and posteriorly, to the conjunctiva and areolar tissue. Extremely minute in its character, it is conceived by many authorities to be merely a deep origin of the orbicularis palpebrarum, but it really appears to be a distinct muscle, as it is always present; at least, we have never observed its absence.

Action.—To compress the lachrymal sac, as well as to draw the puncta backwards, thus placing them in a favourable position to receive the tears.

As it appears to be the natural course to examine the lachrymal apparatus in this stage of the dissection, we shall do so without hesitation, although by pursuing this course we must sacrifice arrangement to convenience.

The appendages of the eye that can be now considered with advantage, are the eyelids, brows, the lachrymal sac, and nasal duct, and this may be done on the opposite side, which is still untouched.

The Eyelids are two pendulous curtains, which cover, when closed,

the anterior surface of the globe, but in their ordinary condition are separated by an elliptical space, of varying magnitude in different individuals; they are of unequal size, the superior being three times as large as the inferior, which rarely extends above the margin of the cornea, while the superior is bounded above by an arch of hairs, called the eyebrows, directed obliquely upwards and outwards, and sometimes meeting across the dorsum of the nose, though generally a space intervenes between them; the integument in which they are set is thick and strong, and this is again supported by the orbicularis and corrugator supercilii muscles, from which, however, it is separated by a quantity of fatty tissue. The brows by their depression, combined with the erection of the hairs which compose them, are of great service in shielding the organ of vision from intense light; and also in directing the perspiration that might otherwise reach eyes into a more legitimate channel, while they likewise, in addition, materially, conduce to the symmetry of the forehead.

The structures forming the lids, from superficial to deep, are the skin, areolar tissue, orbicularis muscle, tarsal cartilage, palpebral ligaments, expansion of the levator palpebræ, and conjunctiva—the levator, however, being absent in the lower lid. Of these, the skin is fine, thin, and smooth, transversely rugated both on the upper and lower lids, but not very sensitive, and presenting internally and externally a sulcus parallel with the chiasma, while at the margins it becomes continuous with the conjunctiva, by a transition almost imperceptible. The areolar tissue beneath the skin is lax and reticular, permitting with facility the occurrence of serous effusion, but at the margins it is dense, so that the skin is very adherent in this situation, but in no single point does it ever present the character of a fascial covering, which serves to account in some degree for the separation of the muscular fibres before alluded to. The muscular layer has already been fully described, and on removing it the palpebral ligaments and tarsal cartilages are seen on the same plane; the tarsal cartilages are two in number, one for each lid—that for the upper, much the larger and best marked, is semilunar in figure, presenting two surfaces, two edges, and two cornua; the superficial aspect, which is convex, is covered by the orbicularis, while the deep, which is concave, corresponds to the globe of the eye, and is lined by the conjunctiva, and the expansion of the levator palpebræ superioris; on this surface, a number of vertical but irregular grooves mark the situations of the Meibomian glands; the superior margin is thin, and receives the attachment of the levator palpebræ and palpebral ligament, while the inferior or ciliary edge is thick, and bevelled in such a direction that when the lids are closed a triangular canal results, two of its sides being formed by the cartilages, and the

base by the globe of the eye, supposed to be for the passage of the tears; it has been asserted that this canal only occurs after death, when the globe has collapsed, but observation proves this idea to be more ingenious than correct. The orifices of the Meibomian follicles are seen a little posterior to the centre of the lid, while into the anterior margin the cilia or eyelashes are implanted; of the two cornua the internal is the more acute, and is fixed in its position by a slip of the tendo oculi, while the external is firmly attached to the corresponding canthus by the external tendo oculi. The inferior tarsal cartilage is not more than two lines in depth, sometimes consisting of the thick ciliary edge only, whilst the superior is in its deepest portion fully half-an-inch; but, with the exception of the levator palpebræ, their relations are similar.

Palpebral Ligaments.—At the margin of the orbit the periosteum of that cavity becomes continuous with a similar tissue from the external surface of the frontal bone above, and with that of the malar and maxillary below; and the dense structure thus formed by the union of both proceeds, to be attached to the orbital margins of the tarsal cartilages, under the name of the superior and inferior palpebral ligaments; these retain them loosely in their situations, becoming weak and thin at the internal canthus, where they are continuous with the tendo oculi; externally they decussate, forming a thick round cord superficially, which may be termed the external tendo oculi, and which is firmly connected to the malar bone; the deep portion here being very broad, apparently for the purpose of compensating for the excavation in the orbital edge of that bone. The internal tendo oculi, is about a quarter of an inch in length, and consists of a superficial and deep portion; the former thick and round internally, where it is attached to the nasal process of the superior maxillary bone in front of the groove for the lachrymal sac; but externally it becomes twisted and flattened, and divides into two well-marked slips, which are attached to either tarsal cartilage, covering the lachrymal canals; while the deep portion of this tendon is undefined, thin but strong, and adheres intimately to the edges of the groove for the sac, which it appears to protect from atmospheric pressure.

The Eyelashes, or ciliæ are strong, stiff hairs, forming a double, and sometimes a treble, row in the inferior margin of each lid: those in the superior being more numerous, stronger, and longer, than those of the lower, while in both they are always shortest externally, and deficient in the internal sixth on account of the inversion which this portion undergoes during the action of the orbicularis muscle; they are also curved, so that their convexities look towards each other, to prevent their interlocking with each other when the eyelids are accurately closed. Their principal use is to break up the

rays of light, and thus protect the eye from any sudden glare, as well as to entangle, like a net, any foreign bodies that might suddenly approach and strike on the globe.

Conjunctiva.—In order to form a correct idea of this structure, which belongs to the class of mucous membranes, divide by a transverse incision the external canthus, and reflect the lids, when it will be seen to consist of two portions, the palpebral and ocular. Eble, however, arranges it into three, the dermoid, mucous, and serous portions, calling that which lines the lids the dermoid, being a continuation of the dermis; and that part intermediate between the lid and the globe, mucous; while the corneal covering he considers to be serous in structure. Commencing at the margin of the lower eyelid, where it is continuous with the skin, it will be found to pass into the Meibomian follicles, and also into the puncta; then lining the posterior surface of the lower lid, it is reflected from it on the fibrous ocular fascia and sclerotic, and next passes upwards over the cornea, forming internally the plica semilunaris, and caruncula; from the superior portion of the globe it is reflected forwards on the upper lid, forming in the angle of reflection the superior palpebral sinus, from which it is carried into the ducts of the lachrymal gland, and then descending to the margin of the lid, it again passes into the superior set of Meibomian glands and puncta, and terminates by continuity with the integument. The conjunctiva of the lids is thick, vascular and villous, covered by squamous and ciliated epithelium, and but loosely adherent to the subjacent parts; in the superior palpebral sinus it is thinner, less vascular, and exceedingly loose, while at the outer side it has similar structural characters, but forms in this situation a deep sinus, like the superior palpebral, for the purpose of allowing the rolling of the globe downwards and inwards, according to the usual view, but really to permit the motion in a contrary direction, or upwards and outwards. At the inner canthus the semilunar fold is placed with its concavity directed outwards, and is generally said to be the rudiment of the third eyelid in the predaceous birds, but it is certainly placed there to allow the rolling of the eye outwards. In some persons, and particularly those who have resided for a lengthened period in warm climates, this fold is large, lax, and protrudes to some extent between the lids when they are opposed. At the internal extremity of the plica, the caruncula lachrymalis forms a projecting pea-shaped tubercle, consisting of a congeries of mucous follicles, surrounded by conjunctiva, small in the child, but gradually increasing with age, so as sometimes to project between the lids, while short hairs are also occasionally visible from its surfaces. Several uses have been ascribed to it—namely, to act as a barrier to prevent the escape of tears from the triangular depression

at the internal canthus (lacus lachrymarum); to prevent the accurate approximation of the punctal portion of the lids, so as to allow the tears to enter those openings; to oppose the too great inversion of the lids; and lastly, to secrete an additional quantity of mucus, to defend the reservoir from the saline and irritating character of the tears. The sclerotic portion of the conjunctiva is pale, but thick, the closeness of its adhesion increasing as it approaches the cornea, on which the epithelium is still present, but the anterior elastic cornea, a thin and perfectly transparent structure, constitutes its basement membrane. In the superior and external part of the upper palpebral sinus, from twelve to sixteen small openings are with difficulty seen, forming a semi-ellipse, occasionally appearing as dark points (Zinn); these are the openings of the ducts of the lachrymal gland, from which the tears are effused on the free surface of the globe; they may be brought more fully into view by rubbing the conjunctiva corresponding to their openings with any coloured fluid, as ink or white paint.

Meibomian Follicles.—At the junction of the edge with the posteriors surface of the lids, numerous small openings are seen, from forty to fifty in the upper, and about thirty in the lower lid; lying between the conjunctiva and the tarsal cartilages which they groove. Each follicle, as it commences at the orifice, consists of a single tube, but this bifurcates, and sometimes communicates with a similar division on each side; while the terminations near the orbital margin of the cartilage may be cœcal; and, indeed, this arrangement is the most frequent. From the sides, smaller tubes likewise pass off, and these also subdivide, ultimately terminating in grape-like bunches of cœcal extremities; they secrete a resinous fluid for the purpose of preventing the escape of the lachrymal secretion over the edges of the lids, while small, straight, but, in diseased conditions, tortuous vessels are seen running towards the base of each follicle, from which small branches are continued to the orifice, where a circular anastomosis is formed; and in scrofulous children, where the lids are thin, these follicles may be often observed through the skin and tarsal cartilage. At the internal sixth of the lid the orifices are no longer visible, as at this point are situated the puncta lachrymalia, which are two in number, one above and one below, represented by annular projections, with a foramen in the centre, looking backwards; and certainly situate in the substance of the tarsal cartilage. Now introduce a pin curved, with its concavity directed upwards, into the inferior punctum, and press it inwards towards the nasal process of the superior maxillary bone; this will show the direction of the lachrymal canals, which are two in number, leading from the punctal orifices to the outer side of the lachrymal sac; each canal being curved, with the concavities

turned towards each other, and consisting of a tubule of mucous membrane, surrounded by a sheath from the reflected layer of the tendo oculi. We have observed that they as frequently open into the sac by a distinct as by a common orifice; being in relation, posteriorly with Horner's muscle and conjunctiva, and anteriorly with the tendo oculi and orbicularis muscle. Raise now the tendo oculi from its attachment to the superior maxillary bone, and reflect it outwards; take a dry skull for the examination of the lachrymal sulcus. This will assist the student in acquiring a correct idea of the relations of the most important of the appendages of the eye.

Lachrymal Sac.—Oval in shape, and about three quarters of an inch in length, consisting of two portions,—the osseous sulcus, in which it is lodged, and the membranous saccule. The osseous portion is a semi-ovoid depression, formed by the grooved posterior edge of the nasal process of the superior maxillary, and the anterior half of the lachrymal bone; the anterior margin curved, is bounded by the tendo oculi, and sometimes by a projecting crest of bone, for its attachment; posteriorly the edge is straight, and limited by the origin of Horner's muscle; inferiorly its junction with the nasal duct is indicated by a spur of the superior maxillary, which is directed backwards; while its superior termination is marked by the naso-frontal suture; the sulcus is deeper below than above, its greater depth in this situation resulting from the standing out of the maxillary bone; this projection being sometimes so great that a knife passed directly backwards will fall external to the sac, but the nearer to the lower edge of the tendon the instrument is introduced, the more easily is the cavity reached, in consequence of the peculiar arrangement of the bony sulcus.

Internal Attachment of the Tendo Oculi.—Now that the lids have been divided, and one attachment of the tendon raised and reflected outwards, it will be seen that this structure really consists of four portions, but all inseparably united with each other. One layer, thin but strong, is attached to the ridge of the os unguis; a second, to the nasal process of the maxillary, where it articulates with the frontal, bounding the sac above; this being continuous with the last by its posterior edge, and in front with the thick straight tendon which is attached to the superior maxillary above and in front of the sac; while the fourth portion is a continuation of the latter downwards, on the anterior edge of the lachrymal groove. About one-third of the sac, or occasionally even less, is above the straight tendon; this variation, however, not depending on the size of the latter, but rather on the point of attachment of the tendon itself to the bone. On laying open the cavity, the mucous membrane lining it is observed to be reddish and soft, and adherent to the bone by a fibrous layer;

while inferiorly its junction with the nasal duct is marked by a circular fold; but this is rarely complete, being merely visible on the anterior part, its appearance in fact depending on that osseous spur before alluded to in the description of the bony framework. If the anterior nares are now dilated and a probe passed into the nasal duct, its extremity will be seen projecting beneath the inferior spongy bone, about an inch from the anterior opening, thus indicating the passage by which the lachrymal secretion reaches the nose. The tears secreted by the lachrymal gland are poured out on the free surface of the globe by the ducts, and collected in the chiasma by the action of the lids; the fluid passes towards the internal canthus, urged in that direction by the horizontal movement from without inwards of the lids, and also by gravitation, in consequence of the external canthus being on a plane superior to the internal; while the orbicularis muscle or tensor tarsi at one moment compressing the sac, and at the next producing by a sudden relaxation a tendency to a vacuum within that cavity, draws backwards at the same moment the puncta into the lake of tears, and thus the fluid is forced into the sac by atmospheric pressure; its descent through the nasal duct, following as a matter of course.

Nerves, and Vessels of the Lids.—The lachrymal nerve sends a branch to the upper eyelid, which communicates with the supra-trochleator branch of the frontal forming the superior tarsal arch; and a communication between the infra-orbital nerve, and infra-trochleator forms the inferior; while the portio dura sends a branch to the muscle, but not to any other structure.

The Arteries, are the superior, and inferior palpebral branches of the ophthalmic, communicating in the upper lid with the frontal, and supra-orbital, and in the lower with the infra-orbital.

Levator Labii Superioris Alæque Nasi.—A thin narrow slip of fleshy fibres, arising from the nasal process of the superior maxillary bone, and sometimes extending as far upwards as the frontal; it descends on the side of the nose, and is inserted by two slips, one into the dense skin of the ala of that organ, the second into the upper lip.

Relations.—Above, it is overlapped by the orbicularis, but below it is pale and subcutaneous, while it lies on the bone, the ala of the nose, and compressor nasi.

Use.—To expand the nostril in forced inspiration, to express contempt, and raise the upper lip.

Levator Labii Superioris, (Proprius) arises broad and flat from the orbital margin of the superior maxillary bone, above the infra-orbital hole; the fibres pass downwards, converging, and are inserted into the upper lip, and orbicularis oris.

Relations.—It is covered by the orbicularis palpebrarum, and the facial nerve. It lies on the levator anguli oris, infra-orbital nerve, and vessels, with the facial artery, which afterwards emerges between its inner edge, and the common elevator.

Action.—To elevate the upper lip; and here it should be remarked that those two last muscles are very generally described as a single mass.

Pyramidalis Nasi.—A narrow slip, continued from the occipito-frontalis above, and inserted into the aponeurosis of the compressores nasi.

Relations.—It lies on the dorsum of the nose, and on the triangular cartilage, and is covered by the skin, to which it intimately adheres, while it is separated from its fellow by a cellular interval, wider below than above.

Use.—To raise the alæ, and to draw down the skin at the inner part of the brow, as well as to assist the corrugator supercilii in expressing anger.

Compressor Nasi.—Triangular in shape, and seen by raising the levator labii; arises narrow from the inner part of the canine fossa; and, passing forwards and inwards, becoming wider as it proceeds, terminates in a thin aponeurosis, which is continuous on the dorsum of the nose with that of the opposite side.

Relations.—It is covered by the levator labii, skin, and lateralis nasi artery; and lies on the bone, and alar cartilage.

Use.—To compress the nostril, if the alæ are projecting; but if concave, to dilate the opening.

Depressor Labii Superioris Alæque Nasi.—To expose this muscle let the upper lip be raised, and the mucous membrane dissected from the side of the frænum, when it will be observed arising narrow from the myrtiform fossa above the incisor teeth of the upper jaw; the fibres then radiate from this point in a direction upwards and outwards; the inferior to be inserted into the orbicularis oris, the middle into the deep surface of the lip, and the superior into the alæ nasi.

Relations.—The upper margin corresponds to the compressor nasi, and it is covered by the orbicularis oris, levator labii superioris alæque nasi, and mucous membrane, while it is supported on the deep surface by the bone. It is so intimately connected with the orbicularis that it is often considered as a portion of that muscle, those of opposite sides being separated by the frænum, and a small ascending branch of the united coronary, named the artery of the filtrum.

Action.—To depress the upper lip and ala of the nose; while the lower fibres may likewise elevate the lip.

Now draw the angle of the mouth downwards and forwards, and thus make tense the following muscles:—

Zygomaticus Major.—Arises fleshy and flat above the lower edge of the malar bone, but soon becoming rounded, passes obliquely downwards and forwards, to be inserted into the angle of the mouth.

Relations.—It is covered by the orbicularis palpebrarum, branches of the portio dura, with a quantity of fat, and lies on the bone, transverse facial artery, and vein, masseter, buccinator muscles, the fat in which it is buried, and facial vein and artery.

Zygomaticus Minor.—Sometimes wanting, arises from the upper part of the malar bone above and in front of the major, passes downwards and forwards, and is inserted into the upper lip and orbicularis oris.

Relations.—It lies on the bone, levator anguli oris, and facial vein, and is covered by the orbicularis palpebrarum and integument. This muscle is frequently united at its origin with the fibres of the orbicularis, and at its insertion with the levator labii superioris, of which it might be considered an additional origin.

Action.—These muscles draw upwards and backwards the angle of the mouth and upper lip, as in tetanus.

Raise the levator labii, together with the last muscles, and expose the following:—

Levator Anguli Oris vel Musculus Caninus.—Arises thin from the canine fossa, external to the compressor nasi, passes downwards and a little backwards, and is inserted into the angle of the mouth, and the orbicularis oris, a slip being often continued downwards to the triangularis oris.

Relations.—It is covered by the orbicularis palpebrarum, levator labii superioris, and the infra-orbital nerve and artery, which is interposed between them, and lies on the bone, buccinator, and mucous membrane. Sometimes it is fasciculated at its origin, and then many of its fibres are inserted into the integument.

Action.—To elevate the angle of the mouth, and thus deepen the tegumentary sulcus extending from the ala of the nose to the angle of the mouth; this is known as the abdominal angle, in consequence of its characteristic contour in disease of that cavity.

Oribicularis Oris.—Surrounds the oral aperture, and consists of two semi-elliptical planes, united at the commissures; the fibres are of unequal thickness in different individuals, turned outwards at the free margin, and intersecting with each other at the angles of the mouth, the superior being united with the lower fibres, and the inferior with the upper fibres of the buccinator. Beneath the integument of the filtrum, or that space of skin immediately below the nose, a band of fibres pass, at first upwards, and then turn forwards, to

be inserted into the anterior extremity of the septum nasi, and this might be separately described as the naso-labialis muscle. The superior segment of the orbicularis extends in depth, from the septum to the free margin of the lip; and the inferior, from the transverse depression bounding the chin above, to the free border of the lower lip.

Relations.—It receives the insertions of the labial, and angular muscles, and lies on the mucous membrane and coronary arteries, while it is covered by the integument.

Action.—To diminish the oral aperture; assisting also in prehension, and in the articulation of certain consonants.

The ORAL MUSCLES, connected with the lower jaw, are four pair proper, namely,—musculus risorius of Santorini, triangularis oris, quadratus menti, and levator labii inferioris, with one common to the upper and lower jaw,—the buccinator.

MUSCULUS RISORIUS.—Consists of a flat plane of pale muscular fibre, evidently a portion of the platysma myoides, arising from the masseter, and angle of the jaw, and inserted into the angle of the mouth and integument; wide at its origin, narrow at its insertion, and unequally developed in different individuals, it covers the lower portion of the parotid, the masseter, triangularis oris, facial vein, artery, and buccinator, and lies immediately beneath the skin. We have never seen this muscle extending to the occipital or mastoid process, as described by Cruveilhier, but have frequently observed its total absence.

Action.—To draw downwards and backwards the angle of the mouth, as in laughter.

TRIANGULARIS ORIS, seen by raising the risorius, arises thin and fleshy from the side of the ramus of the lower jaw, from two lines in front of the masseter, as far forwards as the mental foramen; the portions ascend, the anterior upwards and backwards, and the posterior vertically, to be inserted thin and narrow into the angle of the mouth, where it becomes continuous with the levator anguli.

Relations.—It lies on the ramus of the jaw, the mental nerve, and artery, which separate it from the quadratus menti, on the buccinator and facial artery at its insertion, but at its origin this vessel is posterior to it, and separates it from the masseter; while it is covered by the skin, fascia, and platysma; at the commissure of the lips, so intimate a connexion exists between this muscle and the levator anguli, as well as with the zygomaticus major, that they would seem to form a single muscle, with three points of origin.

Action.—To depress the angle of the mouth; and if acting in combination with the musculus caninus, to diminish the aperture in the transverse diameter.

QUADRATUS MENTI.—Somewhat square, and intimately adherent

to the skin which covers it, arises from the side of the body of the lower jaw, between the mental foramen and symphysis; the fibres pass upwards and inwards, and are inserted into the half of the lower lip.

Relations.—It is covered by the skin and a yellowish fatty tissue, which sinks between its fibres, and also by the triangularis oris, mental nerve, and artery; while it lies on the bone and the levator of the lower lip. A small space always intervenes between the muscles of opposite sides, in which can be felt below, even through the integument, the mental prominence.

Action.—To depress the lip, and draw it outwards and downwards, making it tense transversely.

Levator Labii Inferioris, is seen by everting and dissecting off the mucous membrane from the posterior part of the lower lip; but there is always some difficulty in separating the muscles of opposite sides, as they are intimately united in the middle line. It arises from a small depression below the incisor teeth; and passes downwards and forwards, to be inserted into the deep surface of the quadratus menti.

Relations.—It lies on the bone, and is covered by the quadratus menti and mucous membrane; its insertion assisting in forming the prominence of the chin.

Action.—To raise and project forward the lower lip.

Buccinator, is seen by removing the zygomaticus, and a quantity of fat that lies beneath the ramus of the jaw; it is irregularly quadrilateral in figure, consisting of a flat plane of fibres, arising from the external side of the three posterior alveoli of the upper jaw, as far forwards as the tuber, and from an oblique line on the outer side of the ramus of the inferior maxilla, corresponding to the two last molar teeth; and in the interval between them from a strong aponeurosis,—the pterygo-maxillary, or bucco-pharyngeal, which extends from the point of the external pterygoid plate, and tuber maxillare to the inner side of the root of the coronoid process, where it joins the mylohyoid ridge, giving origin by its anterior edge to the buccinator, and by its posterior to the superior constrictor of the pharynx; from these attachments the buccinator passes forwards, the inferior fibres ascending, the superior descending, and the middle passing horizontally forwards; the superior to become continuous with the upper segment of the orbicularis oris; and the superior with the lower; whilst the middle are inserted into the angle of the mouth; a decussation thus taking place of the superior and inferior fibres, but not of the middle.

Relations.—It is covered by skin, fat that separates it from the ramus of the jaw, insertion of the temporal, and the anterior edge of

the masseter muscle; by the levator and depressor anguli oris, zygomaticus major, and minor, and the musculus risorius, the facial artery and vein, transverse facial artery, buccal branches of the portio dura, and Steno's duct, by which it is pierced in its posterior and superior third or angle; while it lies on the mucous membrane and buccal glands.

Action.—To draw backwards the angle of the mouth, and thus oppose the orbicularis oris; or when the cheeks are distended, to expel the air or fluid which the mouth may contain. When expelling air the action of the orbicularis may graduate the column, as when playing on wind instruments, and hence the name buccinator or trumpeter's muscle. It also presses the food between the teeth, thus assisting in mastication and deglutition.

For the VESSELS of the face, see VASCULAR SYSTEM.

For the NERVES, see NERVOUS SYSTEM.

GENERAL REMARKS.—The muscles of the face are in many subjects but slightly developed; while in others they are well marked, producing a decided contour of the more prominent points of the countenance. Their number is not less remarkable than the peculiar association of their action, which they evince during expression, and the various evidences of mental emotion, which they display, whether as the offspring of pleasing sensations, or the indication of painful impressions. These sudden changes are in part volitional; but under many circumstances the features are thrown into forms exhibiting perfectly the working of the innermost thoughts, notwithstanding the most violent efforts which the individual may put in action in order to control them. Habit exercises a considerable influence on their action; and the frequent repetition of the same expression may leave a peculiar contour, although the sensation which caused it has vanished; in this way producing those striking alterations of the features, which continue as the outward signs of those deep mental operations that mark the dissimilarity of man from all other animals. Independent, however, of expression, their action is important as the regulators of the several openings with which they are connected, as the eye, nose, and mouth; but as the action of each has been described with its anatomy, we will avoid any further allusion to the subject, referring the student to the work of Sir C. Bell on Expression.

DEEP MUSCLES OF THE FACE.

The DEEP MUSCLES of the face, or, as they are commonly called, the muscles of mastication, are four pair,—masseter, temporal, and the external and internal pterygoids, which we will now proceed to describe in order as enumerated.

Masseter.—Quadrilateral in shape, tendinous above, thick and fleshy below, covers the external side of the ramus of the lower jaw, and consists of three portions, which should be examined successively. The first or superficial or anterior portion, arises thick and tendinous from the lower edge of the malar bone and its apophysary tubercle; as well as from the zygomatic arch of the temporal to within half-an-inch of the articulation; continuing tendinous for one inch and a half of its course, it then becomes fleshy, and, passing downwards and backwards, is inserted into the external side of the ramus and angle of the jaw. To examine the second or posterior portion, it must be exposed by raising the anterior portion; this may be done by commencing at the posterior edge, and dividing the tendinous septa which attach it to the bone, when it will be seen to arise from the zygomatic arch of the temporal, as far back as the tubercle for the origin of the external lateral ligament; the fleshy fibres then pass downwards and forwards, to be inserted tendinous into the ramus of the jaw, beneath the anterior as far down as the angle. The third, or deep, or transverse portion, can only be exposed by removing the zygoma, and turning it outwards; it arises fleshy from the internal surface of the arch, and passes forwards and inwards, to be inserted into the outer side of the coronoid process of the lower jaw, where it closely adheres to the insertion of the temporal muscle.

Relations.—It is covered by the parotid, Steno's duct, the transverse facial artery, and veins, branches of the portio dura, platysma, and fascia, inferior fibres of the orbicularis palpebrarum and the zygomaticus major; leaving a small part of the posterior portion superficial immediately in front of the articulation; while it lies on the ramus of the jaw, the insertion of the temporal, masseteric nerve and artery, external pterygoid, fat, and buccinator. When a transverse section is made of the muscle, the tendinous origin is observed to be continued through the fibres, forming in fact septa, and dividing it into numerous compartments.

Action.—This is an exceedingly powerful muscle, in consequence of its fibres being inserted at right angles to the lever on which it acts. As a whole, it raises the lower jaw; but if the anterior fibres act alone, they elevate and draw it forwards, while the posterior elevate and draw it backwards; thus the alternate action of the muscles of opposite sides produces a rotatory movement of the jaw. If the mouth be widely opened, these muscles assist in dislocating the condyle forwards.

The Temporal Aponeurosis, dense, white, and semicircular in shape, attached above to the curved ridge on the frontal, parietal, and mastoid portion of the temporal bone, and below inclosing the zygomatic arch between its layers, consists of two strata, differing

in strength and density, and separated by a small quantity of fat, the zygoma, the middle branch of the temporal artery, and a twig of the orbital division of the superior maxillary nerve. The superficial layer is strong, with interlacing fibres; the deep, weaker, but intimately adherent to the muscular fibres beneath, which it retains in the proper position during their contraction. The aponeurosis having been examined may now be raised, at the same time carefully dissecting off the masseter from the ramus of the jaw; but as yet it is unnecessary to interfere with the zygomatic arch.

Temporal Muscle.—Fan-shaped or triangular, broad and fleshy above, narrow and tendinous below; arises from the fascia which covers it, from all the temporal fossa and inner surface of the zygoma, and by short fibres from the crest on the great wing of the sphenoid bone above the origin of the external pterygoid. The anterior fibres pass downwards and backwards, the middle vertically, the posterior almost horizontally forwards, gliding over the trochlear origin of the zygoma, but beneath the arch itself, and the sphenoidal, forwards and outwards, becoming all attached to the surfaces and edges of a triangular flat tendon, similar in figure to the muscle, between the layers of which it is seen commencing about an inch superior to the arch. This tendon is composed at its commencement of flat bands or fasciculi, which are loosely connected with each other above, but are fused into a dense fibrous mass below, that ultimately splits to embrace the coronoid process of the inferior maxillary bone, into which it is firmly inserted.

Relations.—It is covered by the skin, superficial fascia, temporal artery and its branches, attrahens and attollens aurem muscles, temporo-auricular nerve, with the temporal branches of the portio dura, and temporal branch of superior maxillary; also by a layer of the epicranial aponeurosis, the temporal fascia, zygoma, and masseter. To examine the deep relations, it will be necessary to saw across the zygoma, and carefully dissect down the muscle from above, when it will be seen to lie on the bone, the deep temporal vessels and nerves, a deep layer of fascia, external pterygoid, from which it is separated by the internal maxillary artery; also on the buccinator, with the intervention of a large quantity of fat, that likewise separates it from the pterygo-maxillary ligament. It may now be observed, that the greater portion of the fleshy fibres are situated on the internal side of the tendon, where they are continued down nearly as far as the upper third of the ramus of the jaw, but those on the external terminate above the coronoid process. A bursa is interposed between the posterior fibres and the trochlea of the zygoma; while the middle temporal artery, and the temporal branch of the superior maxillary nerve, pierce the fleshy fibres of the muscle.

Action.—To elevate the lower jaw, by acting on the vertical ramus from behind, as on a bell-crank. It is generally thought that the anterior and posterior fibres will draw the bone, each in their respective directions, and that the posterior can also antagonize the external pterygoid, and avert dislocation; but we believe that it can only act in its totality as an elevator in simple vertical movements,—a circumstance rendered more probable by its greater development in the carnivora. Its contractile energy must be subject to much variation, for although of average size it is often seen pale and weak, with a great predominance of the tendinous over the fleshy structure; neither can the thickness of the muscle be estimated correctly from external evidences,—for in those subjects where the temporal region, before dissection, presented a marked concavity, we have found it to be above the ordinary thickness, this deceptive appearance seeming to depend on the depth of the bony fossa in which it was contained.

At this stage of the dissection, the brain should be removed for future examination; but the dura mater, sinuses, and orbit, may now be dissected with much advantage, for which see ANATOMY OF THE NERVOUS SYSTEM.

THE PTERYGOID MUSCLES are situated deeply beneath the ramus of the jaw, and are with difficulty exposed in the present stage of the dissection. Strictly speaking, their examination should be deferred to a future period, but should it be the wish of the student to obtain a view of them at once, the following course must be pursued: the masseter should be removed, together with the parotid gland, and then the saw should be passed from the centre of the sigmoid notch through the vertical ramus of the lower jaw, as far down as the dental foramen, when a transverse section from before backwards with a slight blow of the hammer on the coronoid process will, as the zygoma had been previously cut, enable the dissector to throw up the detached portion of the bone, with the temporal muscle attached to it. But we think it more advisable, always to defer the examination of those muscles until the dissection of the pharynx is about to be commenced, when a more perfect view of their relations may be obtained.

PTERYGOIDEUS EXTERNUS.—Conical in shape, with the base before and apex behind; lying in the zygomatic fossa, within the ramus of the jaw; arises by short tendinous fibres from the outer surface of the external pterygoid plate, as low down as the triangular process of the palate bone, and from the crest on the great wing of the sphenoid for its whole length, and behind it from an anterior prolongation of the transverse root of the zygoma, and sometimes from the tuber maxillary. The fibres from the pterygoid plate and crest are somewhat distinct at first, but soon form a fleshy belly, that passes back-

wards and a little outwards, and terminates in a round tendon, which is inserted into an oval depression on the anterior and inner side of the neck of the lower jaw; and, by short fibres that pierce the capsnlar ligament, into the interarticular fibro-cartilage, and the inferior synovial sac.

Relations.—It corresponds above to the bone, which is generally hollowed for its reception, its tendons sometimes grooving the transverse root of the zygoma, near the internal extremity; while it is in contact below with the internal maxillary artery and vein, a portion of the parotid, the dental, and gnstatory nerves, and the internal lateral ligament, all of which pass through the pterygoid space, and consequently lie inferior to it; externally, it is covered by the ramus of the jaw, insertion of the temporal muscle, the masseter at the sigmoid notch, internal maxillary artery and vein, the capsnlar ligament, and neck of the jaw; internally it corresponds to the external pterygoid plate, which separates it from the internal pterygoid, behind which it is in contact with its posterior fibres, to the inferior maxillary nerve, with its dental, gustatory, and temporo-auricular branches and otic ganglion, internal lateral ligament, and middle meningeal artery. The depth of the zygomatic fossa influences in a great measure the size of the muscle, it being much larger where the pterygoid plate is concave externally, or where the crest of the sphenoid stands ont boldly, or approximates to the zygomatic arch. The pterygoid and sphenoidal attachments of the muscle, are separated by the internal maxillary artery; and it is also perforated by branches of that artery, and the inferior maxillary nerve, as will be hereafter described in their proper places.

Actions.—To draw forwards the lower jaw, and at the same time to pull in a similar direction the interarticnlar cartilage, so as to adapt the articular eminence to the condyle. When the jaw is depressed, this muscle is an active agent in the production of dislocation of the condyle, if assisted by the muscles that depress the chin; and after the displacement of the bone has taken place, it is in a state of tonic contraction, and certainly not of relaxation, as stated by Nélaton. The production of an artificial dislocation in the dead subject, and an accnrate examination of all the muscles in its vicinity, has satisfied us of the correctness of Sir A. Cooper's views on this subject.

Pterygoideus Internus, oval in shape, and lying internal to the last, arises by tendinous fibres from the internal side of the external pterygoid plate, and from the pterygoid process of the palate bone; it passes downwards, backwards, and outwards, becoming broad and more fleshy, and is inserted into the internal side of the angle of the lower jaw.

Relations.—Externally, it corresponds to the external pterygoid plate, external pterygoid muscle, gustatory and chorda-tympani nerves, internal lateral ligament, which separates it from the inferior dental artery and nerve, internal maxillary vessels, and a small process of the parotid gland; and internally, to the tensor palati, from which it is separated by a dense process of the pharyngeal aponeurosis, superior constrictor, tonsil, from which it is separated below by the pterygo-pharyngeal space, to the stylo-glossus muscle, stylo-maxillary ligament, tonsillitic and facial arteries, and the submaxillary gland. The anterior edge, is in relation with, from below upwards, the mylo-hyoid branch of the inferior dental nerve, mylo-hyoid attachment of the superior constrictor, pterygo-maxillary ligament, and the fossa of that name; while the posterior corresponds, above to the inferior maxillary nerve and otic ganglion, the dental, gustatory, and chorda-tympani nerves, and a portion of the parotid, with the internal lateral ligament. Its origin consists of a strong tendon, continued on its inner aspect, not very dissimilar to the masseter; and the posterior edge is thinner than the anterior, while it is also thicker above than below.

Action.—To elevate the jaw, and also throw it forwards—an effect greatly increased by the muscle being inserted at a right angle to its lever; it assists both the masseter, and external pterygoid muscles in their different actions on the bone.

Glands, may be defined as organs for the purpose of eliminating from the blood mass *effete* materials, which if suffered to remain in the system, would exercise an injurious influence on its several component parts; while they serve also to promote the more perfect performance of the requisite functions of assimilation and absorption. By dividing this system into the conglomerate, conglobate, follicular, and lymphatico-vascular glands, we adopt a division founded on anatomical characters that can be recognized without difficulty, as under the first, the salivary and lachrymal glands, mammæ, pancreas, liver, and kidneys, may be classed. The lymphatics, a particular description of which will be found in the absorbent system, are the only representatives of the second; while the third class includes those glands which are spread over the mucous surfaces, and are more or less simple, being devoid of a ramified, secreting, tubular system, such as the buccal, labial, tonsillitic, Brunnerian. The fourth are principally composed of a vascular structure, without a proper efferent duct, and are variable in size, in contour, and even in persistency, as for instance the spleen, suprarenal capsules, thymus, and thyroid glands; but at present it will be better to limit our remarks to the salivary system only.

The salivary glands are disposed in three pairs, in the immediate

vicinity of the lower jaw, each communicating independently with the buccal cavity. Of the three, the parotid is the largest, the submaxillary is intermediate in size, and the sublingual the smallest; but although they may differ in size and position, still they possess many well-marked characters common to all, as for example, each is related structurally to a large vessel, and occupies such a situation that an almost continual pressure is the result of the natural motions of the lower jaw, while each in structure, again, presents a uniform friability, and each possesses an efferent duct, emanating from it, and forming a communication with the mucous cavities; they are also similarly developed from the mucous layer of the germinal membrane, and are devoid of any proper capsule, save that which is derived from the fascial investments in the neighbourhood. It is extremely difficult to determine their ultimate structure without careful preparation; but it would appear that the ducts commence by oval granular follicles, that constitute the parenchymatous tissue of the glands, and that these are again collected into lobules, from which a short tube, sometimes recognized with difficulty, passes to join the common efferent duct, the latter from their number conferring on the tubular structure a kind of arborescent appearance. The lobules are enclosed by sepimenta of the investing fascia, and the capillaries ramify in the interlobular spaces, while the whole system of tubes is lined by a continuation of the mucous membrane of the mouth; the epithelium being squamous in the larger, but in the ultimate ramifications a granular layer supplying its place. Numerous branches, both of the sympathetic and cerebro-spinal nerves, can be traced into those glands, which are actively engaged in the secretion of the salivary fluid, which varies in quantity from 15 to 24 ounces in the twenty-four hours, and which is a clear transparent fluid, with an alkaline re-action when not overcharged with mucus, which is acid, and consequently may alter or neutralize the re-action of the saliva. It consists of water, a peculiar animal matter named ptyaline, mucus, epithelium, and the granules of the secreting surface; also, chlorides and lactates of potash and soda, phosphate and silicate of lime, soda in combination with mucus, and a peculiar principle, sulpho-cyanogen, which gives to the saliva the character of striking a deep red colour with a persalt of iron. Its uses are various, but not of that importance which the quantity of the secretion would seem to indicate; amongst the most obvious may be enumerated—to promote the sense of taste, to stimulate the stomach, to saturate the acidity of the superabundant gastric juice, to assist in the production and modulation of sound, and, lastly, to act chemically on the amylaceous aliments, by converting them into sugar.

Parotid Gland, occupies a deep recess between the posterior edge

of the ramus of the jaw and the anterior margin of the mastoid process and sterno-mastoid muscle, its salient outline being easily distinguishable in the living subject. The space, however, undergoes considerable variations in size, produced firstly by the position of the head, and secondly, by the movements of the lower jaw; thus if the head is depressed so as to approximate the chin to the sternum, the ramus of the jaw glides backwards over the sterno-mastoid muscle, almost obliterating the recess inferiorly, whilst its greatest degree of magnitude is attained by throwing the head backwards and advancing the chin. Again, when the lower maxilla is depressed to its utmost, the angle passes backwards, covering the space almost completely inferiorly; but during this movement the upper part is increased in a relative proportion by the gliding forwards of the condyle. In the old edentulous subject, and in the infant, the space is large, owing to the absence of the angle, but with the subsequent development of the teeth, it gradually diminishes. The skin in this region is thin, fine, and loosely attached to the subjacent parts, and on raising it some fibres of the platysma are seen, frequently forming a strong, flat, muscular plane, passing from the ramus of the jaw to the angle of the mouth (musculus risorius); while through these fibres may also be observed the anterior branch of the auricularis magnus nerve, imbedded in the substance of the fascia, which constitutes the next covering of the gland.

Fascial Investment.—This is derived from the cervical region, and consists of a strong layer, which not only serves to confine the gland to its anatomical region, but also sends septa into its structure, connecting as well as isolating its lobules from each other. This fascia is attached superiorly to the zygoma, posteriorly to the mastoid process, cartilage of the ear, and tendinous anterior edge of the sterno-mastoid muscle; but anteriorly, while one portion passes backwards over the gland to become continuous with those just enumerated, the other dips beneath its edge, separating it from the masseter, and afterwards, passing deep to be connected with the following, viz.—to the styloid process and internal side of the ramus, together with the angle of the lower jaw, where it forms the stylo-maxillary ligament, and ascending from that point is attached to the vaginal process above, becoming continuous with the internal lateral ligament anteriorly. Thus, the parotid is enclosed in a fibrous pouch with a well-marked outline, that precludes the escape of purulent depôts in several directions; the diffusion is prevented from passing forwards by the dipping in of the superficial layer beneath the gland, and a similar impediment exists to its proceeding backwards by the continuity of the two layers at the anterior edge of the sterno-mastoid; it is circumscribed below by the pouch formed by the

separation of the superficial and deep cervical fasciæ, as they are attached to the stylo-maxillary ligament, and above by the intimate junction of the fascia to the zygoma and vaginal process. It consequently seeks the nearest and least resisting outlet, and this is afforded by the fissures of Santorini in the cartilaginous meatus of the external ear, through which it ulcerates its way and freely escapes. In this capsule, however, certain openings exist, through which parts enter and leave the gland, but these will more properly be submitted to examination when the deeper structures come under consideration.

The parotid is somewhat square on its superficial surface, but often with a caudate prolongation inferiorly, and a similar expansion superiorly in the vicinity of the duct. The following are its boundaries :—superiorly the zygoma, inferiorly a line drawn from the angle of the jaw to the sterno-mastoid muscle, one inch, and sometimes more, below its insertion ; posteriorly the cartilage of the ear, the mastoid process, sterno-mastoid, and digastric muscles ; and anteriorly the ramus of the jaw and the masseter muscle, of which it overlaps the posterior third. From the superior anterior angle of the gland arises Steno's duct, which is about the size of a goosequill and an inch and a half in length, formed by the confluence of the efferent tubes of the lobules ; it passes forwards over the tendinous portion of the masseter, half-an-inch below the zygoma, and at the buccinator becomes involved in a quantity of fat, into which it dips backwards, piercing the superior posterior angle of the latter muscle directly, and then proceeding between the muscular fibres and the mucous membrane of the mouth for some distance, it perforates the latter also, opposite the second superior molar tooth, and below the reflection of the mucous membrane from the cheek to the gums. This duct, immediately after its origin, pierces the fascial capsule, a process of which is prolonged on its surface ; beneath which, is a dense fibrous layer, of a white and glistening appearance, that preserves the figure and gives resistance to the tube, while internally it is lined by a pale mucous membrane, continuous with that of the mouth. Surrounding the duct, just as it pierces the buccinator, are from three to five small granular bodies, communicating with its cavity by short efferent tubes, and it is difficult to say whether these are naked buccal glands, or are the earliest developed portion of the parotid ; but on a plane deeper than these, the duct loses its fibrous coat, and is then merely a mucous tubule to its termination. Above the duct a distinct portion of glandular structure is sometimes present, named socia parotidis--its ducts communicating with that of Steno, and never opening separately into the mouth ; and we are inclined to believe that this process is a subsequent development of the gland

as we never could succeed in detecting its existence in the fœtus or infant. Immediately above the duct are the transverse facial artery and vein, with the socia parotidis, when it exists, and the temporo-facial branches of the portio dura nerve; below it a few masseteric branches from the external carotid, while it is covered by integument, platysma, fascia, fat, and the zygomaticus major muscle. A transverse section, may now be made through the duct, in order to examine its coats; these appear to be of great thickness, and the central cavity so wonderfully small, that we have sometimes experienced great difficulty when trying to introduce the pipe of a mercurial apparatus into its orifice, at the anterior edge of the masseter. For many surgical purposes it is also essentially requisite to be acquainted with the direction and course of the duct, and after many observations and comparisons of the several methods which have been suggested, we think that, half-an-inch below the apophysary tubercle of the malar bone and zygomatic arch indicates its position correctly; though in those cases where no distortion of the parts has occurred from tumours or other diseases, a line drawn from the external auditory meatus to a point midway between the ala of the nose and angle of the mouth will, as the rule, point out its position very distinctly. To return now to the parotid gland: its deep portion may be divided into three processes, which from the situations they occupy may be named glenoid, maxillary, and styloid. Of these the first, the most simple, is wedged into the posterior part of the glenoid cavity of the temporal bone, and is related anteriorly to the capsular ligament of the lower jaw, behind to the cartilaginous meatus, internally to the vaginal process, and above to the bone, chorda tympani nerve, and laxator tympani tendon; the temporal artery runs upwards through it, as well as the temporo-auricular nerve, as it winds outwards to reach the back part of the temporal artery, which it accompanies in the remainder of its course. The glenoid process, is small in the fœtus and infant, in consequence of the processus auditorius not being fully developed, and also in old age, on the disappearance of the teeth, when the condyle of the jaw, passing backwards, causes by its pressure atrophy of the glandular structure. The maxillary portion may differ greatly in size, even on opposite sides of the same subject; caudate and prolonged, it passes inwards between the internal lateral ligament and ramus of the jaw, into the pterygoid space, where it is stated to be in contact with the inferior maxillary nerve, but incorrectly, for it is separated from it by the external pterygoid muscle, but it is in direct relation with the internal maxillary artery. In its course forwards to reach the space alluded to, the caudate prolongation, corresponds externally to the ramus of the jaw and the inferior dental artery, and internally to the dental and gustatory

nerves, to the internal lateral ligament, to the pterygoid muscles, and to the internal maxillary artery. It has been mentioned that this process may vary in size, but sometimes it may be even absent altogether; in this latter case either a simple lobule of fat supplies its place, or a mere vertical sulcus in the gland, corresponding to the ramus of the jaw, signifies the only attempt that has been made at the formation of this process.

The styloid process of the parotid lies in a triangular recess, bounded behind by the posterior belly of the digastric; internally and anteriorly by the stylo-maxillary ligament and styloid process; and on raising it from its deep relations the external carotid is seen perforating the stylo-maxillary ligament, and entering the substance of the gland. If the finger be now passed deep into the space, the internal carotid may be felt, and also the styloid process; but although the glandular structure lies *over* the artery, internal jugular vein, and the eighth, ninth, and sympathetic nerves, it never can be in contact with them, as there does not exist any opening in the capsule, at any part of its deep surface, to allow the gland to reach the vessels above-mentioned. This portion contains generally three lymphatic glands, sometimes only one, and as these may be subject to chronic enlargement, coincident with that change a consequent absorption of the parotid structure is invariably the result. Attention should now be directed to the parts lying in the gland, and first on the surface is seen the auricularis magnus nerve, a branch of the cervical plexus, ascending on the fascia, and dividing into an auricular and facial branch, which are both tegumentary, while descending in front of the tragus, on the horizontal root of the zygoma is observed the temporal vein, lying superficial and anterior to its corresponding artery, and formed above the zygomatic arch by the confluence of the anterior middle, and posterior temporal veins; below the zygoma it receives the transverse facial, and becomes the temporo-facial vein; about half an inch below the condyle of the lower jaw it is joined by the internal maxillary vein, and then receives the name of temporo-maxillary, which accompanies the external carotid in the gland, but separated from it by the portio dura, until arriving at the angle of the jaw it receives the posterior auris, and sometimes the occipital, and then becomes external jugular in the inferior lobe of the gland. By now dissecting deeply in front of the mastoid process, the facial nerve will be seen passing at first downwards, then turning forwards and upwards, being deeply situated behind, but quite superficial at its exit from the gland, giving off between the latter and the stylo-mastoid foramen, three small filaments, called from their destination—posterior auricular to the muscle of the ear, and digastric and stylohyoid branches to the muscles

of the same names; it then divides into two branches,—temporo-facial and cervico-facial, and these communicating in their diverging course through the gland, form the pes anserinus, or parotidean plexus; deeper than this is seen the external carotid, coursing upwards, between the anterior edge of the sterno-mastoid and the ramus of the jaw, being situated very deeply below, but becoming more superficial about half an inch inferior to the condyle, where it divides into the temporal, internal maxillary, and transverse facial branches, having previously thrown off another small artery in the lower part of the gland,—the posterior auris, that runs upwards and backwards to reach the ear. For each of those parts it is obvious that there must be apertures in the fibrous capsule of the gland, to admit of their ingress or egress, but in all cases the fascia is prolonged on the part as it enters or leaves, and thus it still remains perfect as an impervious saccule. The gland may now be dissected up from below, and the deep layer of the capsule removed, when the lingual, spinal-accessory, glosso-pharyngeal, pneumogastric, and sympathetic nerves, with the internal carotid, and jugular vein, will become visible.

THE MUSCLES OF THE NECK.

The neck, may be divided into the anterior and posterior cervical regions, the former consisting of all that space which is included between the ramus of the jaw, and a line drawn from the angle to the mastoid process above; bounded by the clavicles and interclavicular ligament below, and behind on either side, by the anterior margins of the trapezii muscles. This space is unequally concave at either side of the middle line, but presents many well-marked prominences in the latter situation; these can only be properly understood when the student has dissected the parts, and any enumeration of them will, therefore, be avoided for the present, until the larynx is being examined in detail. For the proper dissection of the anterior portion of the neck, the shoulders of the subject should be raised by a block, and the head allowed to droop downwards and backwards, and then secured to one side by hooks, so as to render tense the integument; an incision should now be made from the chin to the sternum, another backwards from the symphysis, along the ramus of the jaw as far as the mastoid process, and lastly a third from the fourchette of the sternum, along the clavicle to its acromial extremity. The skin may now be raised from before backwards, but with great care, as the subjacent parts are extremely liable to injury from the fineness of this superficial investment. The areolar tissue, thus exposed, is fine, but small in quantity, and connects the skin to a muscle called

the platysma myoides, or panniculus carnosus, which is a flat, subcutaneous, muscular expansion, longer than broad, thin, and often scarcely perceptible below, but thick and fleshy above; it arises from the fascia covering the deltoid and pectoral muscles, and passing obliquely upwards, forwards, and inwards, over the clavicle, to which it adheres by a few scattered fibres, reaches the chin and ramus of the jaw, to the latter of which it is slightly attached, and then, decussating with its fellow over the genial eminence, is ultimately inserted into the muscles of the lower lip, angle of the mouth, and lower edge of the orbicularis palpebrarum, some fibres even ascending upon the fascial covering of the parotid, as high as the zygoma.

Relations.—Subcutaneous, some of its fibres being mixed with the basement membrane of the skin, while it lies on the superficial fascia, and the parts which are beneath that structure, with the external jugular vein, and the superficial branches of the cervical plexus.

Actions.—To draw down the integument of the cheek, retract the angle of the mouth, and corrugate the skin of the neck; it is the analogue of the panniculus carnosus of the lower animals, and in the otter we have seen this muscle nearly a quarter of an inch in thickness, acting in this animal as a depressor of the lower jaw; but whether it may have any effect in urging the lymph through the glands and vessels beneath it, is questionable. Before this muscle is removed, the following parts are seen through its fibres:—external jugular vein, auricularis magnus, occipitalis minor, and superficialis colli nerves; also, inferiorly, the supraclavicular, and acromial branches, of the cervical plexus. The external jugular, formed in the inferior lobe of the parotid, as before described, or by an arched branch, which connects it with the internal jugular, passes obliquely downwards, backwards, and outwards; at first beneath the superficial cervical fascia, but as it crosses the sterno-mastoid, becoming superficial to that structure; it continues its course to the posterior inferior triangle of the neck, where it pierces the fascia, and is joined by the transversalis humeri, and colli veins, when, becoming a little dilated, it opens into the subclavian vein, corresponding to the third stage of the artery. On slitting up this vein, it is found to possess two distinct valves; one at the point where it crosses the sterno-mastoid, and the second at its termination, but still they would appear to be quite incapable of preventing regurgitation.

The several superficial nerves mentioned above are all branches of the cervical plexus, and are distributed to the integument of the neck as well as to that below the clavicle, but as they will at a future period receive a full description, we conceive it better not to allude further to them here. (See *Nervous System*).

Fascia or Fibrous Investment, consists of several laminæ, which may be divided into the superficial, middle, and deep, the last being also called the prævertebral layer; between them there is a perfect continuity, but in order that the description of its parts may be better understood, an artificial division has been generally adopted by anatomists.

The Cervical Fascia, commences from the ligamentum nuchæ, and, passing forwards between the superficial and second layer of muscles on the back of the neck, covers the posterior lateral triangle, until, arriving at the posterior edge of the sterno-mastoid, it splits into a superficial and a deep layer, which enclose that muscle; the superficial, stretching upwards over the ramus of the jaw, to which it is attached, then over the masseter and the parotid, reaches and is connected to the zygoma, becoming continuous in the middle line with its fellow of the opposite side, while below, descending over the clavicle and sternum, it is blended with the thoracic fascia; the deep layer, lying beneath the sterno-mastoid, and attached above to the styloid process, and inner surface of the angle, and ramus, of the lower jaw, forms the stylo-maxillary ligament, which separates the parotid from the submaxillary gland; in the supra-hyoid region, it passes beneath the submaxillary gland, constituting its capsule, at the same time surrounding the tendons of the digastric muscles, and stretching between their anterior bellies, where it is remarkably thick and strong, while it also adheres closely to the sheath of the carotids; tracing it down in the middle line, it is greatly augmented in density, and is attached below to the interclavicular ligament and posterior edge of the sternum, this strong layer forming by its margins the pulley for the omo-hyoid tendons, and the action of those muscles in return causing tension of the fascia, thus averting both atmospheric pressure on the trachea, and likewise bearing off the contractions of the sterno-mastoid, during sustained muscular exertion. Inferiorly and externally, it reaches the clavicle, to which it connects the subclavian vein, and the transversalis humeri artery; and, still descending beneath the bone into the axilla, it envelopes the subclavius muscle, and forms the costo-coraco-clavicular ligament; at the outer margin of the sterno-hyoid, and thyroid, a layer passes between those muscles, and a second portion, still crossing the front of the trachea, is firmly stretched between the sterno-thyroid muscles of opposite sides; not, however, adherent to the trachea, but merely covering it, and traceable on its surface, as far down as the bifurcation of that tube, where it is considered, but erroneously, to become fused with the fibrous layer of the pericardium,—a circumstance certainly receiving some support from the position the fibrous structures of the neck bear to the pericardium, in fœtal life. The parts,

therefore, separating the superficial from the deep cervical fascia are as follows:—inferiorly the sternum, the interclavicular ligament, cellular tissue, and a few lymphatic glands; in their whole extent the sterno-mastoid, and, superiorly, the ramus of the jaw with the parotid gland. The deep, or prævertebral layer, will be fully described subsequent to the removal of the pharynx.

The fascia, both superficial and deep, may now be removed, as well as the cellular tissue occupying the interspaces between the vessels and nerves, wheu the following muscle will be fully exposed.

Sterno-mastoid.—Broad and double below, narrow in the middle, but expanded again superiorly; arises by an oval tendon from the upper and anterior surface of the first bone of the sternum, also by a much broader one from the upper edge of the internal third of the clavicle; a narrow triangular space intervenes between these attachments; the sternal portion ascends obliquely upwards and backwards; the clavicular, wider and thinner, passing vertically upwards behind it, uutil arriving at about the middle of the neck they become united, and immediately below the mastoid process, form a strong but thin tendon, expanded posteriorly, which is inserted into the outer and posterior part of the mastoid process, and into the external third of the superior transverse ridge of the occipital bone.

Relations.—It is covered superficially by the skin, fascia, and platysma, external jugular veiu, superficialis colli, and auricularis magnus nerves, parotid, and posterior auris artery; and it lies on the sternum, clavicle, carotid artery, subclavian, and arteria innominata, jugular and subclavian veins, anterior scalenus, sterno-hyoid, and thyroid, and omo-hyoid muscles, thyroid axis, phrenic nerve, the brachial, and cervical plexuses, middle scalenus, sterno-mastoid, and cervicalis ascendeus arteries, rectus capitis anticus major, digastric and splenius, parotid gland, occipital artery, and spinal accessory nerve, which pierces its upper third.

Action.—Both muscles acting, will draw the head downwards and forwards; but if one acts alone it will rotate it to the opposite side; if the head, however, be slightly drawn backwards, these muscles will then increase the retroflexion, as in opisthotonos.

Omo-Hyoid, is found on the side and inferior part of the neck, and consists of two fleshy bellies and a central tendon; the posterior ariscs, flat and tendinous, from the angles of the notch, iu the superior costa of the scapula, and from the ligament of the notch, on which its fibres are sometimes prolonged to the base of the coracoid process; it soon becomes fleshy, and ascends obliquely forwards and inwards, forming beneath the sterno-mastoid, a narrow silvery tendon, which, after passing through a loop in the deep cervical fascia

that connects it to the clavicle, again becomes fleshy, and ascending almost vertically along the outer border of the sterno-hyoid, is inserted into the lower part of the body and cornu of the os hyoides.

Relations.—Its origin is between the supraspinatus externally, and the subscapularis internally; and it crosses the posterior scalenus, brachial plexus, anterior scalenus, phrenic nerve, transversalis colli, and cervicalis ascendens arteries, omo-hyoid plexus, carotid artery, jugular vein, pneumogastric, and sympathetic nerves, thyroid body, superior thyroid artery, and superior laryngeal nerve. It is covered by the trapezius, fascia, external jugular vein, sterno-mastoid muscle; and lastly, by the anterior jugular, when that vein exists. The suprascapular nerve, runs along the upper edge of its posterior belly, and the subclavian artery, and vein below it; while the anterior belly has internal to it the sterno-hyoid, and externally the common and external carotid arteries. The tendon of this muscle is absent in the fœtus and infant, but when formed, gradually increases until the twenty-fourth year.

Action.—To make tense the cervical fascia; but as an element of the shoulder, its action must be very slight. It also draws downwards and backwards the os hyoides, thus acting on the larynx, and pharynx, in deglutition, a function with which it is connected through the descendens noni of the ninth nerve.

Sterno-hyoid.—Flat and narrow, and placed at one side of the mesial line; arises, tendinous and fleshy, from the posterior surface of the first bone of the sternum, sternal end of the clavicle, posterior sterno-clavicular ligament, and the back part of cartilage of the first rib; it ascends obliquely inwards, and is inserted into the lower edge of the body of the os hyoides, internal to the omo-hyoid.

Relations.—It is covered by the sternum, fascia, and anterior jugular vein, and lies on the sterno-thyroid, crico-, and thyro-hyoid muscles.

Action.—To depress the os hyoides, as in deglutition, and assist in the elevation of the sternum in forced respiration. As these muscles converge as they ascend, they are consequently nearer to each other above, than the sterno-thyroid, and hence opposite the crico-thyroid space, they bound laterally the position for the operation of laryngotomy.

Sterno-thyroid.—Flatter and broader than the last, which should be divided to expose it; it arises fleshy, but with short tendinous fibres intermixed, from the posterior surface of the first bone of the sternum, lower down than the sterno-hyoid, and from the cartilage of the second rib. It passes upwards and inwards, and is slightly inserted into an oblique ridge on the ala of the thyroid cartilage, where it appears to give off the thyro-hyoid muscle.

Relations.—It lies on a deep layer of fascia, which separates it from the remains of the thymus gland, on the left vena innominata, within the thorax, and on the trachea; on the right side, above the sternum, it rests on the arteria innominata, right carotid, and subclavian arteries, the internal jugular, and subclavian veins; and on the left side, on the left subclavian and carotid, with veins similar to those on the right, while both lie over the vertebral, and inferior thyroid arteries, lateral lobe of the thyroid body, cricoid cartilage, insertion of crico-thyroid muscle, thyroid cartilage, and thyroid branch of the artery of that name. It is covered by the sternum, and by the sterno-hyoid, and mastoid muscles, but with branches of the omo-hyoid plexus intervening between them. This muscle, is wider than the sterno-hyoid, on the inner side of which its margin projects so as to overlap the trachea, and it is, therefore, between these that the operation of tracheotomy is performed. The width of the muscle would appear to be always more or less dependent on the size of the thyroid body; and we lately had the opportunity of seeing a case where its breadth, owing to the enlargement of the gland, was fully two inches. A wavy tendinous line is sometimes observed in the muscle, a little below the centre, indicating an attempt at a digastric disposition.

Thyro-hyoid.—Seems to be a continuation of the last; arises, by an oblique margin, from the ridge on the side of the thyroid cartilage, and passing obliquely upwards and backwards, is inserted into the lower edge of the cornu of the os hyoides.

Relations.—It lies on the thyroid cartilage, thyro-hyoid membrane, and branch of the superior thyroid artery, sometimes on the superior laryngeal nerve; and it is covered by the sterno-hyoid, and a branch of the lingual nerve that supplies it.

Action.—To depress the os hyoides; but when that bone is fixed, it may elevate the thyroid cartilage, and thus relax the vocal chords by diminishing the crico-thyroid space.

THE TRIANGLES OF THE NECK.

Let the student now direct particular attention to the surgical regions into which the neck has been divided, conceiving that the mesial line divides this space into two symmetrical halves, each presenting a figure somewhat quadrilateral, but longer from above downwards than transversely. Now, as these are crossed by the sterno-mastoid obliquely, two triangles are formed, an antero-lateral in front of that muscle, and a postero-lateral behind it, the former having its base at the ramus of the jaw, and a line prolonged from the angle of that bone to the mastoid process, and the apex at the

sternum; while the base of the latter corresponds to the clavicle, and its apex to the occipital bone, behind the mastoid process of the temporal. These are again sub-divided by the omo-hyoid, as it runs from below and behind, obliquely upwards and forwards, into four lesser triangles, which have been named the anterior inferior, and the anterior superior (but the latter would be incomplete, were it not that the line of the omo-hyoid is continued by the anterior belly of the digastric), the posterior inferior and posterior superior triangles.

Anterior Inferior Triangle, is bounded internally by the mesial line, below and behind by the anterior edge of the sterno-mastoid, and above by the anterior belly of the omo-hyoid, the base being at the mesial line, and the apex at the decussation of the sterno-mastoid, and omo-hyoid muscles. On removing the fascia, the anterior jugular vein is seen coursing along the outer margin of the sterno-hyoid, with branches of the omo-hyoid plexus, formed by the descendens, and communicans noni of the cervical plexus. On raising the anterior part of the sheath, the carotid artery, and jugular vein, are exposed, with the pneumogastric nerve lying behind and between them; while still deeper, on removing the posterior layer of the sheath, the inferior thyroid artery, inferior cervical ganglion of the sympathetic, with the trunk of that nerve, are seen; and still more deeply, the vertebral artery; in the groove between the trachea and œsophagus, the laryngeal recurrent nerve, with the lateral lobe of the thyroid body lying on the trachea, may be observed, and the thoracic duct is likewise visible on the left side.

Posterior Inferior Triangle, bounded below by the clavicle which forms its base, above by the posterior belly of the omo-hyoid, and in front by the posterior edge of the sterno-mastoid, contains a quantity of lax areolar tissue and lymphatic glands, the external jugular, the transversalis humeri and colli, and subclavian veins; the transversalis colli artery crosses the apex of the space, and the transversalis humeri the base, while the subclavian artery lies immediately posterior to the latter, with the brachial plexus on a plane superior and posterior to both.

The Anterior Superior Triangle, may be considered as consisting of two regions: the proper triangle being below the posterior belly of the digastric muscle, whilst above that muscle, and below the ramus of the jaw, the digastric space is situated.

The Superior or Middle Triangle, is bounded behind by the sterno-mastoid, above by the posterior belly of the digastric, and below by the anterior belly of the omo-hyoid, with its apex corresponding to the decussation of the sterno-mastoid and omo-hyoid muscles, and its base to the posterior belly of the digastric. When

the fascia is removed several veins are seen, forming a plexiform and intricate interlacement, called the hyoidean plexus, to the formation of which the facial, external, and anterior jugulars contribute; and on these being turned on one side, the descendens noni nerve is observed on the external and anterior part of the sheath, a further dissection revealing the common carotid artery in its superficial stage, with its division into external and internal or deep carotids, the internal jugular, and its subsidiary veins,—the pneumogastric and branches of sympathetic, and lingual nerves, the latter running parallel, but inferior, to the digastric; the superior laryngeal branch of the vagus is likewise seen crossing deeply behind the two carotids, in its course to the thyro-hyoid space, and in the posterior superior angle, the spinal accessory lying between the sterno-mastoid and digastric, with the following branches of the external carotid arising within the space,—superior thyroid, lingual, facial, occipital, posterior auris, muscular, and ascending pharyngeal arteries.

The Posterior Superior Triangle, bounded below by the omohyoid, behind by the trapezius, and in front by the posterior margin of the sterno-mastoid, contains the cervical plexus, a number of lymphatic glands (glandulæ concatenatæ); forming a chain along the posterior edge of the sterno-mastoid, and the spinal accessory nerve, crossing obliquely towards the acromial edge of the trapezius, with the transversalis colli artery, and twigs of the cervicalis superficialis.

With this brief outline of the contents of those spaces, the student should rest satisfied for the present, and should defer the more particular examination of the several parts enumerated until the muscles of the suprahyoid region have been described.

Digastric.—To see the origin of this muscle, the parotid must be removed, the sterno-mastoid raised, and the splenius capitis drawn backwards. As its name implies, it consists of two bellies, united by a mesial tendon, and the whole muscle takes an arched direction, immediately beneath the ramus of the jaw. It arises narrow from a deep pit or groove, internal to the mastoid process of the temporal bone, and forms a fleshy belly that passes downwards, forwards, and inwards, for about an inch and a half from its origin; it then becomes tendinous, and piercing the stylo-hyoid muscle, is connected to the cornu of the os hyoides by a dense fascial pulley, from which it is reflected upwards, forwards, and inwards, to be inserted into the digastric pit, at the side of the symphysis menti, and below the insertion of the mylo-hyoid.

Relations.—It will be seen that the anterior and posterior bellies of this muscle resemble each other in a very remarkable manner, and hence when viewed together as they are connected by their inter-

vening tendon they represent two cones, with their apices united, a little anterior to the centre—the tendon, being contained in a pulley with a synovial lining, and attached to the os hyoides. In order to produce still further security, the cervical fascia is firmly stretched not only between the tendons, but likewise between the anterior bellies, covering all that space above the os hyoides, and below the chin, and this is sometimes described as the supra-hyoid aponeurosis ; but it should be always borne in mind that this is very variable in its character, and may present, in different subjects, appearances extremely variable.

Relations.—The posterior belly of the muscle, much the longer of the two, rest on the occipital artery which separates it from the rectus capitis lateralis muscle, on the sub-occipital nerve, internal jugular vein, spinal accessory, lingual, pneumogastric, and sympathetic nerves, but at some distance from them; it next crosses over the internal, and external carotids, and facial arteries, stylohyoid muscle; and at the posterior part of the cornu of the os hyoides it again lies on the lingual nerve, on the lingual artery, and hyo-glossus muscle; whilst in the pulley, it conceals the insertion of the mylo-hyoid, and on this muscle the anterior belly lies to its insertion; its superficial relations are fascia, platysma, a small portion of the parotid, the anterior edge of the sterno-mastoid and facial vein, while a few fibres of the stylo-hyoid must, of necessity, lie superficial to it, with the submaxillary gland; the posterior belly is pierced by the anastomotic filament of the digastric branch of the facial nerve, passing to the glosso-pharyngeal, and the anterior is perforated by branches of the submental artery. Occasionally instances have been observed where this muscle did not pierce the stylo-hyoid muscle.

Action.—If the lower jaw be fixed, it will raise the os hyoides; but the posterior belly, acting by itself, will draw the pharynx upwards and backwards, and the anterior upwards and forwards. The principal action of this muscle is to draw the os hyoides upwards directly, both bellies contracting simultaneously, and thus reducing the curve to a straight line. The fascial pulley should now be dissected off, and the digastric turned up over the ramus of the jaw, so that it may be replaced at pleasure, for the purpose of attentively examining the following region.

Digastric Space.—Semicircular in shape, and situated below the jaw; is bounded above by the ramus of the jaw, and a line continued backwards from the angle to the mastoid process; behind, and inferiorly by the posterior belly of the digastric; and in front, by the anterior. This space is again divided into two unequal parts by the stylomaxillary ligament, the one being called the an-

terior, or submaxillary, and the other the posterior, or parotidean region; the latter being the smaller of the two. The anterior digastric space, contains the submaxillary and sublingual glands, the genio-hyoid range of lymphatics, the mylo-hyoid, lingual, and gustatory nerves, the facial, lingual, and submental arteries, with the supra-hyoid muscles; while in the posterior are found from superficial to deep, the auricularis magnus nerve, external jugular vein, lower lobe of the parotid, cervico-facial branch of portio dura, external carotid, styloid process, and origin of styloid muscles, stylo-hyoid ligament, internal carotid, jugular vein, eighth, ninth, and sympathetic nerves, and ascending pharyngeal, and palatine arteries.

Submaxillary Gland.—Intermediate in size between the parotid and sublingual, and consisting of a deep and superficial portion, is situated in the anterior digastric space, and is bounded in front by the ramus of the jaw, which presents an oval depression in this situation for its reception; behind, by the posterior belly of the digastric; externally, by the angle of the jaw, stylo-maxillary ligament, and internal pterygoid muscle; internally, by the anterior belly of the digastric; inferiorly, it is covered by the integument, platysma, and fascia; while superiorly it lies in contact with the insertions of the mylo-hyoid, and stylo-hyoid muscles. The superficial portion, oblong and lobulated, is surrounded by a quantity of lax areolar tissue, which separates it from the fascia, and allows of periodic enlargement; while at the posterior margin the Whartonian duct emerges from the body of the gland, and winds round the posterior edge of the mylo-hyoid, so as to get above that muscle, and lie on the hyo-glossus; a deep process accompanies the duct, forming a linear series of lobules on each side of that tube, and connecting it above to the sublingual gland. The course of the Whartonian duct is first backwards and upwards, then forwards and inwards, over the inferior surface of the hyo-glossus, and while in this situation it lies below the sublingual gland, to which it is connected, but the communication between them is not at all certain; it next winds above the gustatory nerve, getting between the sublingual gland and genio-hyo-glossus muscle, and then running forwards and upwards, it pierces the mucous membrane of the sublingual space opposite the inferior incisor teeth, the exact situation of its termination being marked by a papilla on either side of the frænum linguæ. The facial artery runs through the posterior edge of the body of the gland, occasionally dividing it into two distinct lobes; and the vascular supply, which is very abundant, is derived from this trunk and its submental branch, as well as from the sublingual branch of the lingual artery, while the veins are subsidiary to the formation of the facial. If the posterior margin of the mylo-hyoid muscle be

drawn forwards, or a few of its external fibres divided, on following the gustatory nerve forwards, two branches are seen to be detached from it; these pass downwards to the posterior edge of the gland, and there form a grey swelling or ganglion (the submaxillary), and this again sends two branches upwards to reach the formative nerve further on in its course; this ganglion also receives filaments of the sympathetic, conducted to it by the facial artery, and the branches which it yields are lost in the gland, and on the coats of the duct; the chorda tympani is conceived to be the principal source of this ganglion, and if it be regarded as a branch of the facial nerve, it will probably preside over the active movements of the ducts of the glands. In addition to the foregoing, filaments from the mylo-hyoid branch of the inferior dental nerve can be traced into the substance of the gland, while between it and the ramus of the jaw three or four lymphatic glands are situated for the reception of the absorbents, which are few in number, and of but slight importance.

Structural Anatomy.—The capsule surrounding the lobules being exceedingly weak, it is consequently much more easy to unravel the tissue of this gland than that of the parotid, and the smaller tubes can be shown coalescing to form the ultimate duct, which is remarkable for its large size, the thinness of its coats, and the length of its course, with its vicinity to the mucous membrane of the mouth. When any obstruction occurs to its orifice it readily suffers distention, eventuating frequently in the formation of calculi from the solid elements of the salivary secretion—the amount of this secretion being for each, about four ounces in the twenty-four hours. The superficial portion of the gland may be now raised, and thrown backwards, when the following muscles will be brought into view.

Mylo-Hyoid.—Triangular in shape, with the base at the lower jaw, and apex at the os hyoides, arises by short, tendinous, and fleshy fibres, from the two anterior thirds of the myloid ridge of the lower jaw, extending from the maxillary attachment of the superior constrictor to the symphysis menti; the fibres pass downwards, backwards, and inwards, and are inserted into a central tendinous raphe, common to it and the muscle of the opposite side, extending from the chin to the os hyoides, and also into the upper edge of the body of that bone.

Relations.—Below it corresponds to the submaxillary gland, the anterior belly of the digastric, submental, and facial arteries, mylo-hyoid nerve, facial vein, with the skin, platysma, and fascia; the external edge is related to the superior constrictor, gustatory nerve, deep process of submaxillary gland, stylo-hyoid, and glossus muscles, stylo-hyoid ligament, lingual nerve and artery, and middle constrictor, while the internal is united with its fellow of the opposite side.

If we now remove its insertion into the os hyoides, separate the median raphe, and throw the muscle upwards towards the ramus of the jaw, it will be seen that its upper surface is in relation with the following parts, from above downwards :—the mucous membrane of the mouth, subliugual glands, deep process of the submaxillary, Whartonian duct, gustatory nerve, hyo-glossal plexus, lingual nerve, and at the anterior edge of the hyo-glossus, the ranine artery, as well as with the genio-hyoid, genio-hyo-glossus, hyo-glossus, stylo-glossus, and lingualis muscles.

Action.—To depress the lower jaw, or to elevate and draw forwards the os hyoides, and press the tongue against the teeth if the mouth is closed, or protrude it if it is open. It likewise forms the floor of the mouth, and preserves the outline of the sublingual space when the cavity is distended.

Genio-hyoid.—Short, fleshy, and fusiform in shape, placed beneath the lower edge of the genio-hyo-glossus, of which it appears to be an appendage, arises by a short tendon from the inferior genial eminence, and soon becoming fleshy, passes downwards and backwards, and is inserted into the upper edge of the os hyoides.

Relations.—It corresponds internally to its fellow, from which it is often with difficulty separated ; externally to the sublingual, and deep process of submaxillary gland, lingual and gustatory nerves, hyo-glossus, ranine artery, some distance however intervening ; below, to the mylo-hyoid, and above to the genio-hyo-glossus.

Action.—To elevate the os hyoides, and assist in the protrusion of the tongue.

Hyo-glossus.—Oblong, flat, and fleshy, arises from the upper edge of the cornu of the os hyoides ; its fibres pass upwards, backwards, and outwards, and are inserted into the side of the tongue.

Relations.—Externally and anteriorly it corresponds to the lingual nerve, hyo-glossal plexus, gustatory nerve, Whartonian duct, stylo-glossus, and sublingual gland, the mylo-hyoid, stylo-hyoid, and digastric muscles, and it lies on the lingual artery, which separates it from the middle constrictor, and stylo-hyoid ligament, on the superior constrictor, mucous membrane, and genio-hyo-glossus muscle.

Action.—To elevate the os hyoides, and draw down the sides of the tongue, so as to cause a convexity of the dorsum of that organ.

In order to expose fully the genio-hyo-glossus, saw through the jaw at its symphysis ; draw the tougue from the mouth, and afterwards separate the muscles of opposite sides.

Genio-hyo-glossus.—Triangular in shape, arises narrow and tendinous from the middle genial eminence ; and from this point the fibres diverge, the superior arching upwards and forwards to be inserted into the tip, and the middle, into the base of the tongue, while the

inferior curve downwards and backwards, and are attached to the upper edge of the body of the os hyoides.

Relations.—Internally it is in contact with its fellow, except immediately above the hyoid bone, where a narrow triangular plate of cartilage, sometimes ligament, intervenes, a thin stratum of yellowish fatty tissue uniting the two muscles, particularly below; externally it corresponds to the mylo-hyoid, hyo-glossus, and the inferior lingualis, the sublingual gland, the Whartonian duct, and deep process of the submaxillary gland, with the gustatory and lingual nerves and ranine artery; the genio-hyoid lies along its lower border and the frænum linguæ, with a slip of the sublingual gland, corresponds to its upper edge.

Action.—The anterior fibres may depress the tip of the tongue into the sublingual space; and the middle may draw downwards the centre of the organ, rendering it concave transversely; while the inferior will retract the tongue when the os hyoides is fixed, as in deglutition; or they may also, by acting from the chin, and raising the hyoid bone, protrude the organ, as is evidenced in hemiplegia, where the muscle on the sound side, by elevating the bone, protrudes the tongue to the opposite or paralyzed half of the body. On the outer side of this muscle is seen a longitudinal muscular fasciculus, named:—

INFERIOR LINGUALIS, pale in colour, and sometimes indistinct, wide behind, but narrow before, attached posteriorly to the os hyoides, from which it passes forwards to the apex of the tongue.

Relations.—Externally it corresponds to the hyo-glossus; internally to the genio-hyo-glossus; below to the ranine artery, branches of the lingual and gustatory nerves, the filaments of the latter piercing its substance; and above to the central muscular nucleus of the tongue.

Action.—To shorten and retract the tongue.

SUBLINGUAL GLAND.—The third representative of the salivary system, situated immediately below the mucous membrane of the mouth, scarcely exceeds in size a filbert, although a different estimate might be formed of its magnitude until fully isolated from the deep process of the submaxillary; it is bounded above by the mucous membrane of the sublingual space, below by the mylo-hyoid, which separates it from the submaxillary gland; anteriorly by a depression on the posterior surface of the symphysis menti; posteriorly by the root of the tongue; internally by the hyo-glossus, and genio-hyo-glossus muscles, above the edge of which it sometimes passes to reach its fellow of the opposite side; and externally by the deep process of the submaxillary gland. Its capsule is weak, and the whole gland very movable; while its ducts are numerous and divisible into three

sets: four or five opening on a fold at the inferior and lateral part of the tongue; three to seven on the sublingual space behind the inferior canine teeth; and five or six uniting to form a single tube, which either joins with or more frequently follows the course of the Whartonian duct, opening external to it on the mucous membrane of the sublingual space. The amount of the secretion of both glands is about two ounces in twenty-four hours; the nervous supply being derived from the gustatory nerves, and the vascular from the sublingual artery.

The STYLOID MUSCLES, viz. the stylo-hyoid, stylo-glossus, and stylo-pharyngeus, should now be examined; but in doing so, care should be taken to avoid injuring the carotids or their branches.

STYLO-HYOID.—A narrow fleshy fasciculus, arises by a round tendon from the outer side of the styloid process, about its centre, and winding at first backwards and outwards, and then turning forwards so as to surround two-thirds of the external carotid, it becomes fleshy, is pierced by the tendon of the digastric, and continues its course to be inserted into the body of the os hyoides, superficial to the hyo-glossus.

Relations.—It lies on the styloid process, the external and internal carotids, jugular vein, pneumogastric, lingual, and sympathetic nerves, partly on the digastric, and hyo-glossus muscles, and on the lingual, and facial arteries; while it is covered at its origin by the external carotid, facial vein, submaxillary gland, and at the os hyoides by a few fibres of the mylo-hyoid. This muscle is very rarely absent, and the stylo-hyoid branch of the portio dura supplies it.

Action.—To draw the os hyoides, larynx, and pharynx upwards and backwards, but it cannot act independent of the digastric.

STYLO-GLOSSUS.—Arises tendinous from the anterior and internal part of the styloid process, from its centre to its point, and from the stylo-maxillary ligament; it passes obliquely forwards and inwards, and is inserted into the side of the tongue, external to the hyo-glossus, extending as far as the apex, where it unites with its fellow of the opposite side to form a loop.

Relations.—Externally it corresponds to the parotid, from which it is separated by the fascia, to the stylo-maxillary ligament, internal pterygoid, the tonsillary artery intervening, external carotid, mylo-hyoid muscle, and submaxillary gland; and internally to the internal carotid, jugular vein, superior constrictor, ascending pharyngeal artery and hyo-glossus; while separating its lower edge from the stylo-pharyngeus, are seen the styloid process, the stylo-hyoid ligament, glosso-pharyngeal nerve, and ascending palatine artery.

Action.—To retract the tongue, and to draw it to one side; but

when both these muscles act, the tongue is rapidly withdrawn into the mouth, if protruded.

Stylo-pharyngeus.—Longer than the last; arises from the back part of the root of the styloid process, and, passing downwards, forwards, and inwards, insinuates itself between the superior and middle constrictors, and is inserted into the posterior part of the thyroid cartilage, from the superior to the inferior cornu.

Relations.—It is covered by the external carotid, facial artery, the glosso-pharyngeal, and superior laryngeal nerves, middle and inferior constrictors; and it lies on the internal carotid artery, jugular vein, pneumogastric, glosso-pharyngeal, lingual, superior laryngeal, and sympathetic nerves, ascending pharyngeal artery, mucous membrane, and superior constrictor. We have seen this muscle very frequently split by the glosso-pharyngeal nerve.

Action.—To raise and dilate the bag of the pharynx.

The Thyroid Gland, which should now be examined, is a glandular mass, occupying the front and sides of the trachea and larynx, to a greater or lesser extent in different cases, consisting of two lateral lobes, with a central or connecting slip; each lobe is convex on its external surface, narrow and pointed above, large and wide inferiorly and somewhat concave on its tracheal aspect; while the middle, crossing the trachea in front of the second, third, and fourth rings of the trachea, though it may pass behind that tube or the œsophagus, connects the two lateral lobes together. This isthmus or middle lobe is however very variable as to shape; it may be either a simple transverse band, or thick and convex, projecting anteriorly like a tubercle; or lastly, it may be wholly absent, the two lateral lobes being, in this case, fused into a single mass in the middle line. The lateral lobe is covered by the sterno-hyoid and thyroid muscles, the latter always corresponding in width to the development of the gland; while by its deep surface it rests against the œsophagus, laryngeal recurrent, inferior thyroid artery, inferior constrictor, trachea, cricoid cartilage, and inferior third of the thyroid; the outer lip overlaps the sheath containing the carotid, jugular vein, and pneumogastric nerve, the amount of the overlapping depending on the size of the gland; the upper edge, concave and embracing the lower edge of the cricoid cartilage, corresponds to the ramus thyroideus of the superior thyroid artery; while from the centre, and sometimes from the right or left margin, a thin band may be observed to ascend, either in the middle line or on one side, to reach the thyroid cartilage, or, more rarely, the os hyoides—a structure considered by many as a muscle, and known as the "levator thyroidei." The view of its muscularity would seem to be principally derived from the circumstance, that in some cases it is distinctly fibrous in its appearance; but

these certainly constitute the exception, for in many cases where a favourable opportunity occurred, we have examined it attentively in the recent subject, and have found it always to present a character similar to that of the body of the gland, but with some slight modification; in one instance, indeed, the band having become swollen in the notch of the thyroid cartilage, resembled in its external characters a small lymphatic, but a section at once revealed the same tissue that constitutes the peculiar characteristic of the gland itself. Again, we have seen it with an interrupted structure, that is to say, partly fibrous and partly glandular, presenting the appearance of a string of berries; being plainly the remains of the laryngeal portion of the gland, its diminution occurring spontaneously with the development of the larynx.

Structure.—The gland is divisible into lobes and lobules, the latter being composed of cells of an angular or flattened shape, containing nucleated cells, and an oily fluid; when hypertrophied these cells become circular, resembling fat vesicles, but differing from them in possessing fibrous walls. Mr. Simon believes this structure to be an organ supplemental, in fœtal life, to the development of the great nervous centres.

The gland adheres very intimately to the first ring of the trachea, but there is not a trace of any duct at this point, nor in any situation in connexion with the air-tube.

Its arterial supply is derived from the superior, and inferior thyroid arteries, and sometimes a fifth branch (the middle Thyroid of Neihbur) passes upwards, in front of the trachea, from the arch of the aorta or arteria innominata. Its nerves are derived from the sympathetic, but we have not succeeded in tracing any filaments from the pneumogastric itself into the gland, except a doubtful branch of the recurrent, which seems to terminate in the interannular membrane of the trachea. The lymphatic vessels, open into the glands above the sternum. The *nerves, lymphatics*, and *veins*, superior, inferior, and transverse, will be described in their proper systems. The weight of the gland varies from one ounce and a half to two and a half ounces, but may be subject to excessive enlargement (goitre), induced by the influence of climate and peculiarities in the aqueous aliments; it is also comparatively larger in the fœtus than in the adult, and is developed as two distinct and independent bodies, the middle lobe being the latest to appear.

The student should now proceed to the dissection of the vessels, commencing with the subclavians, and then following the anatomy of the carotids and their branches. He may now also trace the several nerves, to which allusion has been made in the account of the muscles; full descriptions of both being given in the proper section devoted to

their examination, to which reference should now be made. At present he may proceed with the dissection of the pharynx, and larynx; and in order to prepare the former for examination, the trachea and œsophagus, together with the great vessels and nerves, should be cut across a little above the sternum, and raised carefully from the deep muscles of the neck, as high as the base of the skull. If it should be desirable to preserve the skull, the atlas may be disarticulated from the occipital bone, but if otherwise, and this is the mode to be preferred, place the saw between the styloid and mastoid processes, and cut through the temporal and basilar process of the occipital bones; and so detach it. Tow or hair, must now be introduced within its cavity, so as to distend the bag, and make tense the muscles; this object being facilitated by first passing the material used for distention, through the aperture of the mouth, and subsequently completing the process from the œsophagus.

The PHARYNX, is a musculo-membranous bag, of a conical form, with its base above at the cranium, and apex below at the œsophagus, extending from the skull to a point on a level with the fifth cervical vertebra. The following are its general relations :—Behind it corresponds to the longi colli, and recti antici muscles, covered by the prævertebral fascia; in front, from above downwards, to the openings of the Eustachian tubes, and posterior nares, to the velum, isthmus faucium, base of the tongue, epiglottis, glottis, and posterior surface of the larynx; and laterally, to the great vessels and nerves, of the neck, and pterygo-pharyngeal spaces. The structures entering into its formation are muscles, fibrous membrane, and a mucous lining, forming part of the gastro-pulmonary system; the muscles being divided into the intrinsic and extrinsic, the former represented by the constrictors, the latter by the stylo-pharyngeus and palato-pharyngeus, with other supernumerary slips to be hereafter described.

The CONSTRICTORS, thin plates of muscular fibre, are symmetrically arranged, three on either side, called inferior, middle, and superior, overlapping each other from below upwards, the inferior being consequently the most superficial, and the superior the deepest of the three. This arrangement cannot be seen when the pharynx is removed, owing to the muscles being covered by a strong but thin fascia, which adheres more intimately to the inferior constrictor than to either of the others, and is very strong in this situation; but when this is removed, though the fibres may be seen, the several origins require for their exposition a more elaborate dissection and definite description, in order to be thoroughly understood.

INFERIOR CONSTRICTOR.—Its origin is exposed by throwing up the sterno-hyoid and thyroid muscles, and then removing the lateral

lobe of the thyroid body, when it will be seen to be somewhat square in shape, the upper and lower edges being oblique, the posterior straight, and the anterior irregular. It arises from an oblique line on the ala of the thyroid cartilage, between the sterno-thyroid ~~below~~ above, the crico-thyroid ~~above~~ below, and the insertion of the stylo-pharyngeus behind; from the inferior cornu of the same cartilage, from a ridge on the cricoid, between the crico-thyroid and crico-arytenoideus posticus, sometimes from the first ring of the trachea or thyroid body, and more rarely by a slip from the superior and posterior edge of the cricoid cartilage, which, when it exists, is connected with the proper arytenoid muscles; from these points of origin the fibres pass upwards and backwards, and are inserted into a central tendinous raphe, extending from the cuneiform process to the œsophagus on the posterior surface of the pharynx. The lower margin of this muscle embraces the œsophagus, and behind its cricoid origin, the inferior laryngeal nerve, and the inferior laryngeal branch of the thyroid, glide between it and the œsophagus, to reach the muscles of the larynx; while the upper margin overlaps the middle constrictor, from which it is separated by the superior laryngeal nerve and artery, the superior cornu of the thyroid cartilage, and the insertion of the stylo-pharyngeus muscle. By now dividing the inferior constrictor in the middle line, and reflecting it forwards towards the thyroid cartilage, the peculiarity of its origin may be seen, consisting in fact of three arches, the first extending from a tubercle in front of the superior cornu to a second inferiorly, at the junction of the posterior with the middle third of the ala of the thyroid, a tendinous band stretching between those two points; it is next attached to the inferior cornu on the external surface, but sometimes a little anterior to it, thus forming a second arch smaller than the last, beneath which the crico-thyroid muscle passes to its insertion; and ultimately a third arch is formed between the last attachment and the cricoid origin, beneath which is the crico-thyroid articulation. These arches are not always equally well marked, but can in every case be discovered by careful dissection.

Middle Constrictor.—Triangular in shape, apex at the os hyoides, and base at the tendinous raphe posteriorly. In order to see its origin, the digastric, stylo-hyoid, and mylo-hyoid muscles, with the hyo-glossus and the lingual artery, should be removed, when it will be seen to arise from the upper edge of the cornu and appendix of the os hyoides, from the stylo-hyoid ligament, and from the posterior edge of the thyro-hyoid ligament; the fibres take a diverging direction, the superior passing obliquely upwards and backwards, the middle horizontally, the inferior downwards and backwards, and those from the thyro-hyoid ligament almost vertically downwards,

to be inserted into the middle tendinous raphe and cuneiform process of the occipital bone. The lingual artery, covered by the hyo-glossus, lies on its origin, and it is overlapped in its course backwards by the inferior constrictor, while it again partially conceals the superior, from which it is separated by the stylo-pharyngeus muscle and glosso-pharyngeal nerve; its superior insertion likewise separates the lesser sinuses of Morgagni, beneath the occipital bone.

Superior Constrictor.—Irregular as to shape and outline; may be exposed by drawing the pharynx to one side, and removing the stylo-glossus, with the parts occupying the interval between it and the internal pterygoid (the pterygo-pharyngeal space), when it will be found to be attached to the base of the cranium by an aponeurosis, which should now be examined.

Pharyngeal Aponeurosis.—This structure is divided into portions, which are really continuous, but which have received distinct names, derived from their attachments; hence they have been called the occipito-pharyngeal, petro-pharyngeal, pterygo-pharyngeal, and bucco-pharyngeal divisions. The occipito-pharyngeal, is attached above to the basilar process of the occipital bone, and, passing downwards between the constrictors and mucous membrane, but becoming weaker in its descent, except in the middle line where it forms the raphe, finally terminates by being lost on the external surface of the œsophagus; while externally its margin becomes connected with the petro-pharyngeal process, their junction forming an acute angle, which lies internal to the carotid artery, and jugular vein, but separated from them by the superior cervical ganglion of the sympathetic. The petro-pharyngeal portion, is attached to the petrous portion of the temporal bone, external to the levator palati and Eustachian tubes and passing forwards and downwards, splits into two layers, to form the pterygo-pharyngeal portion; one of those layers is connected to the posterior lip of the internal pterygoid plate on the internal side of the tensor palati, and the other, which is much stronger, to the crest which bounds internally the navicular fossa; on the internal side of the last-named muscle, close to the hamular process, both unite and cross to the inner side of the root of the coronoid process of the lower jaw as the pterygo-maxillary ligament or bucco-pharyngeal aponeurosis, which can still be traced to the mylo-hyoid ridge of the lower jaw, here constituting another origin of the constrictor, which should, with good reason, be named the mylo-pharyngeal process. Through the instrumentality of this continuous fibrous sheet, the superior constrictor is attached to the several points enumerated, but anteriorly it has yet an additional connexion to the side of the base of the tongue, as the glosso-pha-

ryngeal, or mylo-glossus muscle. It may therefore be said in general terms, to arise from the side of the base of the tongue, from the posterior third of the mylo-hyoid ridge, from the pterygo-maxillary ligament, from the hamular process, and internal pterygoid plate, from the petrous portion of the temporal bone, and cuneiform process of the occipital. The fibres run in curves between the several points of attachment, with the concavities directed upwards; and in the intervals between the fixed points certain parts are found; as, for instance, between the maxillary and pterygoid attachments, the internal pterygoid muscle and gustatory nerve are seen, between the pterygoid and petrosal, the muscles of the palate and Eustachian tube, and lastly, between the petrous and occipital, two semilunar spaces are observed, called the sinuses of Morgagni and Vere, where the muscular tissue is altogether deficient, allowing the fibrous aponeurosis to become distinctly visible.

The Extrinsic Muscles of the Pharynx, are the stylo-pharyngei and palato-pharyngei, the former of which have been already described in the dissection of the neck, and the latter will be examined with those of the palate. But in addition to these there are certain accessory slips, that are only present, however, in some cases, and are commonly known as the muscles of Albinus. One of these, called the pterygo-pharyngeus, arising from the hamular process and internal pterygoid plate, and, passing downwards over the tendon of the tensor palati, expands and is attached to the mucous surface of the superior constrictor, being often connected to the soft palate, and contained in its mucous fold. A second fleshy band occasionally arises from the petrous portion of the temporal bone between the levator palati and the pharyngeal aponeurosis, with which it is intimately blended; this sometimes expands, and, investing the Eustachian tube, is then continued as far as the palato-pharyngeus, which may have induced Winslow to consider and describe it as a distinct muscle, under the name of salpingo-pharyngeus, on account of its attachment to the Eustachian tube, but the term petro-pharyngeus would appear to be more applicable. A small fasciculus, more like ligament than muscle, the spheno-pharyngeus, may also arise from the spine of the sphenoid bone, internal to the internal lateral ligament of the lower jaw, and external to the Eustachian tube, over which it arches downwards, to be attached to the pharynx (Riolanus); but in the majority of cases this is merely a process of the ligament, forming an arch beneath the Eustachian tube, and becoming continuous with the pharyngeal aponeurosis. Another slip, called the occipito-pharyngeus, has also been described as arising from the cuneiform process, and descending to be inserted with its fellow of the opposite side into the middle line; but this certainly

has no existence, and the mistake seems to have originated from the fact of a few fibres of the rectus capitis anticus major being attached to the pharynx, which may have induced the idea of a distinct muscle. The pharynx is supplied by the ascending pharyngeal, palatine, superior, and inferior thyroid arteries, as well as by branches from the internal carotid and lingual; the pharyngeal plexus of nerves is destined for it solely, but it receives in addition branches from the superior and inferior laryngeal, and glosso-pharyngeal.

Action.—It will be observed, that the bag of the pharynx is so attached to certain fixed points, as at its superior part serve to keep its walls apart. Thus at its highest limit it is stretched between the pterygoid plates; beneath this, between the rami of the jaw, and still lower, between the cornua of the os hyoides, all of which, while they tend to preserve its width, likewise divide it anatomically into nasal, buccal, and laryngeal portions. Of these, the first can suffer but slight alteration either as to length or width; the buccal, on the other hand, in consequence of the mobility of the points to which it is attached, undergoes extensive changes in both directions during the performance of the act of deglutition; while the laryngeal is but slightly affected during this function. From the independence of each constrictor, the gradual contraction of the canal from above downwards is fully insured, for as the function of deglutition is purely reflex, that portion first contracts to which the stimulus is first applied, of course indirectly, as it is on the mucous surface the excito-motor impression occurs, and so is propagated onwards.

The pharynx may now be laid open, by a vertical incision on the back part, and washed out, when the canal is seen to be similar in figure internally, to what its external outline presents: it is lined by a mucous membrane, with seven openings all situated apparently on its anterior wall; four of these being placed above the velum, namely, the Eustachian tubes and posterior nares; and three below that fold,—the isthmus faucium, glottis, and œsophagus.

Posterior Nares.—Two oval openings, one inch in length from above downwards, and from half to three-quarters of an inch transversely, form the only communication of the nose with the pharynx; they are bounded above by the body of the sphenoid bone, below by the palate plates of the palate bone; internally by the vomer, crest of palate, and rostrum of the sphenoid; and externally by the internal pterygoid plate, and nasal process of the palate bone. It must, however, be borne in mind that in the recent state those openings are somewhat diminished in size by the prominence of the mucous lining.

Eustachian Tube.—In order to dissect this canal, let the levator and tensor muscles of the palate be exposed behind the internal pterygoid process, when the cartilaginous portion of the tube will be seen; it and the bony part combined being about one inch and three-quarters in length, extending from the anterior wall of the tympanum to the posterior nares. In consequence, however, of a dilatation at its tympanic extremity, and a similar enlargement at its nasal, the latter being of the greater size, the tube taken in its whole length is trumpet-shaped; the osseous portion, which is three-quarters of an inch in extent, is continued in the substance of the temporal bone between the outer side of the petrous and inner of the squamous divisions, the termination appearing in the retreating angle between them; from this point the cartilaginous part commences, and is about one inch in length, and directed forwards and inwards, so as to open at the posterior edge of the inferior spongy bone. Strictly speaking, a deficiency exists inferiorly and internally, and this is made up of fibrous tissue derived from the pharyngeal aponeurosis, while at its termination its posterior lip is prolonged in a remarkable manner so as to form a striking excrescence or prominence anteriorly.

Relations.—Superiorly it is in contact with the union of the spinous process of the sphenoid with the petrous portion of the temporal bone, both being grooved so as to form a half cylinder, deeper before than behind for the reception of the tube, also the cartilage closing the anterior lacerated hole, and the Vidian nerve, with the root of the internal pterygoid plate, and body of the sphenoid; externally it corresponds to the middle meningeal artery, temporo-auricular, and inferior maxillary nerves, the latter being separated from it by the otic ganglion, to the tensor palati, internal pterygoid plate, and pterygo-pharyngeal aponeurosis; and internally to the petro-pharyngeal aponeurosis, which it pierces, to the levator palati, and mucous membrane. The principal use of the tube is to convey air into the cavity of the tympanum, in order to support the membrane stretched across the outer opening of that portion of the middle ear; it also subserves, in a greater degree than is generally supposed, to the function of direct audition, while it is likewise of service in carrying off any excess of secretion that might accumulate in the tympanic cavity. Occasionally its canal may be obstructed, a change inducing Eustachian deafness, and under those circumstances its permeability may be discovered by compressing the nostrils, closing the lips, and then forcing the air contained in the cavity of the mouth backwards; and if by this means it obtains access to the tympanum, it produces a crackling of the membrane perfectly audible to the experimenter. The tube is absent in fishes, and has a common opening at the posterior nares in birds. Its vascular supply is derived from the posterior

auris, ascending pharyngeal, and the descending palatine, with twigs from the internal carotid arteries; and its nervous from a branch from the lesser palatine, tympanic plexus, and otic ganglion. The mucous membrane lining the tube is pale, soft, and thick, and the epithelium clubbed and ciliated, the latter character being peculiar to that of the tube alone, and never extending to the lining of the tympanum.

Velum Pendulum Palati, is composed of a double fold of mucous membrane, and a distinct fibrous or aponeurotic layer, with the expanded attachments of five pair of muscles, and presents a quadrilateral outline, with the uvula projecting from the lower margin; the anterior superior border is attached to the posterior edge of the palate plates of the palate bones, and is continuous in this position with the mucous membrane of the mouth and nose; the posterior inferior margin exhibits a double curve or arch, with the uvula projecting and forming the centre; the nasal surface, convex, looks upwards and backwards; and the oral concave, downwards and forwards, while the edges laterally are attached to the superior constrictor. The mucous membrane should now be dissected off from the nasal surface as well as from the inner aspect of the pharynx, and thus will be brought into view three pair of muscles, namely, levator, and tensor palati, with the motor uvulæ.

Levator Palati.—Round, thick, and fleshy above, broad and expanded below, arises by a short tendon from the petrous portion of the temporal bone in front of the carotid foramen, and from the cartilaginous portion of the Eustachian tube on its posterior surface. It passes at first downwards and forwards, and then, expanding and turning inwards, is inserted into the dorsum of the soft palate, some of its fibres terminating in the palatine aponeurosis, and others crossing the middle line to become continuous with those on the opposite side; the latter being extremely short and often tendinous in structure.

Relations.—Externally with the tensor palati, superior constrictor, and the Eustachian tube, and internally with the mucous membrane; while its horizontal portion is covered by the motor uvulæ, and lies on the palato-pharyngeus.

Action.—To raise the soft palate.

Tensor, or Circumflexus Palati.—Fleshy above and tendinous below, arises from the fossa navicularis at the root of the internal pterygoid plate, from the base of the spine of the sphenoid, and anterior surface of the Eustachian tube; it forms a thin, fleshy fasciculus, flattened from side to side, which descends along the internal pterygoid plate, and terminates in a round tendon that plays around the hamular process, from which it is separated by a bursa;

it then expands, and is reflected horizontally inwards to be inserted into the aponeurosis of the velum, and also into the posterior edge of the palate bone.

Relations.—Externally with the internal pterygoid muscle, from which it is separated by a fibrous layer; and internally with the internal pterygoid plate, superior constrictor, and Eustachian tube, which separates it from the levator palati; the horizontal portion is continuous with the palatine aponeurosis, and above and before the levator is covered by the motor uvulæ.

Action.—To make tense the velum, and if the lower part is fixed, to dilate the Eustachian tube.

Motor Uvulæ, occupies the middle line of the palate, and arises by a long tendinous slip from the spinous process of the palate bone; it passes at first backwards, then curves forwards, and is inserted into the areolar tissue of the uvula.

Relations.—Above, it has the mucous membrane; and below, the levator palati muscles, with the palatine aponeurosis. These muscles, though often described as a single fleshy mass, under the name of azygos uvulæ, are always separated by an areolar line, and the opinion entertained of their occasional absence, probably arose from examining them too near the palate bone, where their structure is fibrous.

Action.—To shorten and elevate the uvula.

Palato-pharyngeus.—Seen by drawing upwards the velum, and dissecting off the mucous membrane behind the tonsil, also from the under surface of the palatal fold itself, arises broad, fasciculated, and fleshy in structure from the inferior surface of the palatine aponeurosis, and becoming narrow, passes downwards and backwards, to be inserted into the superior cornu, and posterior border of the thyroid cartilage.

Relations.—In the palate, it lies below the insertions of the superior muscles; but in the pharynx, it is between the mucous membrane and superior constrictor, where it forms the posterior half-arch of the palate. Its action will be described with the palate in general.

Palato-glossus.—Smaller and shorter than the last, seen by removing the mucous membrane in front of the tonsil, arises broad from the inferior surface of the velum, passes downwards, and becomes narrower, but soon again expands, and is inserted broad into the side of the tongue, with the stylo-glossus.

Relations.—Internally it corresponds to the mucous membrane; externally to the superior constrictor; and posteriorly to the tonsil. It forms the anterior half-arch of the palate.

The mucous membrane of the velum, is formed on the nasal aspect by a continuation from that cavity, while that on the lower aspect is prolonged from the mouth; both layers uniting at the posterior

free edge and apex of the uvula. This membrane is comparatively thick and soft, pale on the upper, but more vascular on the lower surface; the epithelium partaking of the characters peculiar to the cavity in its vicinity, being columnar and ciliated on the nasal surface, and squamous on the oral aspect. In addition to the five pairs of muscles already described, a dense aponeurosis occupies the upper half, and this is continuous above with the fibrous layer of the hard palate, with that of the nasal fossæ, and of the Eustachian tubes; it receives the insertions of the several muscles, but does not extend to the inferior border, where the two layers of mucous membrane are in contact, with the intervention, only, of lax areolar tissue and glands, which are largely prolonged into the uvula. The glands are involuted mucous tubules, and are more numerous on the inferior than on the superior surface; their cœcal extremities lie in the areolar tissue. This latter constituent of the velum is lax, and permits of rapid and extensive effusion, in which the uvula also participates. The uvula, is a pyramidal projection, but it may be sometimes either flat or bifid, or occasionally absent altogether; but this is a very rare occurrence; in the normal state it is seen curving forwards above the base of the tongue, but without actually touching it. In relaxation of the palate, subsequent to repeated attacks of inflammation, particularly of an asthenic character, it frequently becomes elongated to such an extent as to lie continually on the tongue, but while in this position it produces little or no irritation, and that which may be observed always depends upon a sudden inspiration, or an attempt at deglutition, which may carry it so far back as to touch the epiglottis. That such is the true explanation of the resulting spasmodic cough, is proved by the fact that when the palate is swollen to such an extent as to lie in direct and continual contact with the tongue, an occurrence of this kind rarely, if ever, occurs. The soft palate is of utility in the expression of sounds, both natural and acquired, but its integrity is of paramount importance in connexion with the function of deglutition. During the performance of this act, when the food is passing over the retracted and elevated root of the tongue, when at the first impression of irritation the upper part of the pharynx contracts, and the isthmus of the fauces is closed, the tendency to regurgitation through the nares which naturally exists is said by Magendie to be obviated by the elevation of the soft palate, but the subsequent observations of Dzondi prove that a more complex mechanism fulfils this important office. The palate, no doubt, suffers tension at this moment, but then the palato-pharyngei contracting form an oblique plane directed downwards and backwards, the fissure between them being accurately filled up by the elevated and shortened uvula; and thus a perfect partition is estab-

lished between the nasal and buccal portions of the pharynx, completely preventing regurgitation.

The vascular supply is derived from the ascending and descending palatine arteries, while the nerves which influence it are the palatine branches of Meckel's ganglion.

Isthmus Faucium.—The natural opening of communication between the mouth and pharynx, is in shape transversely oval, and bounded above by the velum and uvula; below by the base of the tongue, and laterally by the half-arches of the palate and the tonsil. This opening is subject to continual variations in figure, depending on the position of the tongue, the movements of the palato-pharyngei and palato-glossi, and also on the degree of development of the tonsil.

Tonsils, or Amygdalæ.—Are oval or almond-shaped follicular glands, placed in a recess between the anterior and posterior pillars of the palate, large above, narrow and pointed below, and covered by a fine mucous membrane prolonged into the follicles which constitute the greater portion of these bodies. Each tonsil has anteriorly the palato-glossus; posteriorly, the palato-pharyngeus; below, the base of the tongue; and externally, the superior constrictor, and internal pterygoid muscle—the vicinity of these muscles evidently providing for a certain degree of pressure on the gland for the purpose of urging the secretion of mucus from the follicles. Several large vessels are also in close proximity to the gland; the external carotid lying superficial to it, the internal posterior to it, and the facial anterior and inferior to it. When the tonsil enlarges, it becomes of necessity much closer to those vessels by its external surface; the pterygo-pharyngeal aponeurosis, however, obviates its enlargement to any considerable extent in that direction, the principal increase being towards the mucous surface, impinging on the cavity of the mouth, so that in applying a cutting instrument to the internal surface of an enlarged tonsil, it is really more remote from any large vessel than in the healthy condition of the gland. The tonsil is very freely supplied with blood from the following arteries: —Internal carotid, ascending pharyngeal, tonsillary, ascending and descending palatine, all of which form a plexus surrounding the gland, from which the capillaries freely enter its structure; it possesses but slight sensibility, although supplied by branches from the glosso-pharyngeal, gustatory, and sympathetic nerves.

The student should now direct attention to the cavity of the mouth, with its contained organ,—the tongue; and this may be examined either by making a vertical section of the skull and face, or by dividing the buccinator, and removing one-half of the ramus of the jaw. The cavity of the mouth is of an oval figure, bounded above, by the hard and soft palate; below, by the tongue and the

sub-lingual space; laterally, by the cheeks, molar teeth, and alveoli; posteriorly, by the isthmus faucium; and anteriorly, by the incisor and canine teeth, with the lips. The superior wall is arched, with the concavity directed downwards, and although fixed and immovable anteriorly, that portion constituted by the floating curtain can alter its position with freedom and facility. The anterior portion of the wall of the cavity, may also be elongated by protrusion of the lips; and a similar enlargement may ensue laterally, by distension of the cheeks; while the vertical space is constantly suffering change in extent, depending on depression and elevation of the tongue. The lining membrane can be traced from the free border of the lower lip on to its posterior surface, and from this to the gum; then over the latter through the intervals between the teeth to its posterior surface, and still backwards, over the floor of the sublingual space to the under surface of the tongue, forming a fold in the middle line (frænum linguæ); from this over the apex and edges of this organ to its base, and by the three glosso-epiglottid folds, on the lingual face and margins of the epiglottis. Superiorly, it can be traced from the free margin of the upper lip to the posterior surface, then backwards on the gum, forming a fold in the middle line, the frænum of the upper lip, while sometimes frænula may be also observed opposite the lateral incisors, indicating the original development of the lip from three centres; it then passes between the teeth to the posterior surface of the gum, from which it is prolonged on the lingual surface of the hard and soft palate, lining also the buccal plane and the outer side of the gums. On the lips the mucous membrane is thin, but very vascular; on the gums, the vascularity is diminished, while the thickness is greatly augmented, in consequence of a dense fibrous layer that adheres to the periosteum, converting it, in fact, into a compound, or fibro-mucous structure. On the buccal structure it is smooth and soft, presenting an elevated fold, corresponding to the anterior edge of the internal pterygoid, and ramus of the jaw, indicating the posterior limit of the buccal space; while on the palate, it is again of a compound structure, hard, dense, and of considerable thickness, a linear depression marking the original symmetrical development of the palate. The glands in connexion with this tract, are follicular, some being mere involutions of the mucous membrane, while others are convoluted in the submucous tissue, but yet simple in constitution, and lined in every case by a prolongation of the common membrane.

The Epithelial Covering, is strong, and forms an uninterrupted layer, by many considered to be cuticular, as it is directly continuous with the superficial covering of the face. Like the cuticle, it may be raised by irritants, forming vesicles similar to aphthæ; or, again,

it may be peeled off in an extensive layer, after maceration. This covering, has always much greater density on the tongue, than in any other situation.

The TONGUE, composed essentially of muscular tissue, being similar to the heart in this respect, is oval in figure, and corresponds to the space included between the horizontal rami of the inferior maxillary bone. When in the natural and unconstrained position, it extends from the incisor teeth to the os hyoides, so that its absolute base is concealed; but if only that portion disclosed when the mouth is opened be considered as representing the figure of the organ, it would then be triangular with the base posteriorly, and the apex in front, free on the dorsum, margins, and the anterior third of the inferior surface. It receives an investment from the oral mucous membrane, and is exceedingly movable,—the motions exercising no inconsiderable influence on the larynx, pharynx, and palate, in consequence of the attachments of the organ, which are as follows: anteriorly, it is connected to the symphysis menti by the frænum linguæ, and the genio-hyo-glossi muscles; posteriorly, to the epiglottis by the glosso-epiglottidean folds of mucous membrane, which are three in number, the central being the largest; superiorly, to the palate by the palato-glossus, and mucous membrane; inferiorly, to the os-hyoides, by mucous membrane, a fibrous layer (hyo-glossal membrane), also by the genio-hyo-glossi, and inferior linguales muscles; externally, to the inside of the lower jaw by the superior constrictor of the pharynx; and above and behind, to the styloid process of the temporal bone, by the stylo-glossus muscle. The tongue presents for examination two margins, two surfaces, and a point or tip; these we now propose to consider in order as enumerated.

The margins are thick posteriorly, but thin and sharp in front, while the inferior surface is smooth and concave, with a triangular mesial depression continued from the attachment of the frænum, with on either side a longitudinal elevation, formed by the linguales and genio-hyo-glossi muscles, the ranine veins being also visible through the mucous membrane. The upper surface or dorsum, as it is usually called, likewise presents a mesial raphe, extending from the foramen cœcum behind, to the point in front, where it forms a notch, the depth of which varies with the tension of the frænum. The mucous membrane on this surface, should be particularly examined, not only with the unassisted eye, but also with a lens of low power, as it is extremely difficult to become conversant with its intimate structure, without a close investigation. This investment exhibits all the several constituents peculiar to its class, namely, a basement membrane, a papillary layer, and an epithelial

covering; each of which should be examined in succession. The basement membrane composed of the two forms of fibrous tissue, is thick, dense, and resisting, and receives the insertions of the superficial muscular fibres, thus assisting in the formation of the outline of the organ; while the surface is marked by a series of papillæ, which consist of two classes, the simple and compound,—the former being found in all situations, but the latter restricted to the dorsal region only. In order that a proper idea may be formed of them, it is requisite to macerate the organ, to remove the epithelial investment; when it will be observed that the peculiar organization found in this situation is not wholly dependent on the epidermoid tissue, but that the subjacent basement membrane participates in the modifications of the surface. Simple papillæ, are found in the largest number on its sides and under surface; but they may be observed also on the dorsum, in the intervals between the filiform and fungiform (compound) bodies, but more scattered in the latter situation. Each consists of a pointed or pyriform prolongation of the basement membrane, covered by epithelium; some being perforated, representing a follicle containing granular bodies or nucleated cells, a single vascular loop, with nervous filaments, completing their organization. Compound papillæ, on the other hand, are divided into three varieties,—the filiform, fungiform, and calyciform, and are restricted exclusively to the dorsum and edges of the tongue, each compound papilla being merely an assemblage of the simple, but modified in arrangement according to the variety with which they are connected.

Filiform, the most numerous, being as twenty to one in comparison with the other varieties, consist of a cylindrical projection, formed of a circularly arranged series of simple papillæ, which are fused into each other at the margins, so as to constitute the wall of the cylinder, but are free at the point, reminding one forcibly of the tentacular arms of the polype, these points varying from sixteen to thirty in number. This circular arrangement is very obvious in the papillæ of the sides and apex, but more difficult to be detected in those of the middle region. On further inspection, a depression in the central part exactly like a mucous follicle is observed, while to each acuminated extremity of the formative simple papillæ, a cylinder of epithelium is attached which is hollow, the walls being composed of scales of that structure, attached by their edges, so as to form a tubule, which are of different lengths, short, and badly defined at the apex and edges, but long and well-marked in the middle region of the tongue. It is in consequence of these filiform prolongations that this class of papillæ has received its name.

Fungiform, occur at the centre of the organ, and are narrow at

the base, and dilated at their summits, the simple formative papillæ beiug flattened, and the epithelium thin, and destitute of filamentous processes. Behind the calyciform class there are a few which appear to be a modification of the fungiform, but they are sessile, and the simple papillæ on their surface are pyriform.

Calyciform, or Papillæ Circumvallatæ, are from twelve to sixteeu in uumber, arranged at the posterior part of the organ in two lines, diverging anteriorly, but meeting posteriorly at the foramen cœcum. Each represents a cup, out of the centre of which is evolved a papilla, sometimes adherent to the surrounding rim—both papilla and margin, being beset with simple papillæ, which are very much flattened; the epithelial investment is thin, and less adherent to these than to any of the foregoing forms. Behiud the triangular space circumscribed by those calyciform papillæ, are two V-shaped spaces, and here the tongue is smooth but irregular, presentiug the opening of numerous mucous glands, to which the mucous membrane has but a slight adhesion. The use of the compound papillæ would appear to be gustative sensibility, but this function is appareutly limited to the point betweeu the foramen cœcum and the apex of the organ. For a further description, see Hassal's *Microscopic Anatomy*, p. 495.

Ou raising the mucous membrane from the dorsum of the tongue, the muscular structure becomes manifested, aud has been divided into extrinsic and intrinsic muscles, the former of which have beeu already described as the stylo-glossus, hyo-glossus, genio-hyo-glossus, glosso-pharyngeus, and the inferior lingualis, although the class to which the latter appertains is doubtful. The intrinsic muscles are,—the superior and inferior linguales, and the ceutral muscular uucleus; the existence of each of which can be showu, by making a trausverse section of the tongue anterior to its ceutre.

Superior Lingualis is formed by a series of fibres, constituting a contiuuous layer ou the dorsum, aud intimately attached to the basemeut portiou of the mucous membraue. Their course is obliquely forwards and inwards towards the raphe, the internal being short, the external much longer, and extending to the point of the tongue, where they are weak; but posteriorly, their thickness sometimes exceeds a quarter of an inch.

Lateral Lingualis consists of three sets of fibres; of which the superficial, most visible at the base, pass downwards and forwards, but are ofteu raised with the mucous membraue. Beueath these, a deeper set pass backwards and downwards, and may be seeu about the centre; and lastly, some longitudinal fibres, derived from the stylo-glossus, form the deepest layer of this region.

Inferior Lingualis.—This fasciculus, lying between the hyo- and

genio-hyo-glossi on each side, has been already described with the extrinsic muscles; and as it often takes an origin from the hyoid bone, it may be justly considered as partaking of the character of both.

By making a transverse section of the tongue, in its centre will be seen an oval mass, but concave below, and of a pale yellowish colour, with a whitish septum dividing it into two symmetrical halves; this is the lingual muscular nucleus, with fibres transverse and vertical, as well as longitudinal, on its upper aspect, extending from the os hyoides forwards for about one inch and a half, related above, to the superior lingualis; laterally, to the stylo-, and hyo-glossus; and below, to the inferior lingualis, and genio-hyo-glossus. By now raising the three folds of mucous membrane attaching the tongue to the epiglottis, and by removing the membrane in the concavity of the os hyoides, a ligamentous layer is seen passing from that bone to the lingual nucleus (glosso-hyoid ligament), while still deeper in the mesial line, but seen more easily from the inferior surface, and between the genio-hyo-glossi, the lingual cartilage appears, triangular in shape, with the base posteriorly, and apex anteriorly; it is, however, very incomplete in its appearance, being pectinated similarly to the septum of the penis; and we have observed it frequently to be nothing more than merely a ligamentous structure, without a vestige of cartilage, and fused with the fatty tissue of the base of the tongue. Three nerves are distributed to the last named organ; the lingual or ninth to the muscular structure; the glosso-pharyngeal to the mucous membrane at the base; and the gustatory to the papillated surface; while the lingual branch of the external carotid, the ascending palatine, and tonsillary arteries, supply it with vascular nutrition.

The functions of the tongue, are so numerous and important that they can here be merely glanced at. It is actively engaged as a material agent in mastication, in deglutition, and in the act of sucking, its retraction producing the requisite vacuum; it also plays a leading part in the articulation of sounds; and, above all, the sense of taste is located in its mucous surface. In many animals, as for example the woodpecker and chamelion, it subserves to the function of prehension, while in reptiles its motions are intimately connected with respiration.

THE LARYNX.

This organ of natural language, in man is situated above the trachea and below the os hyoides, corresponding to the third, fourth, and fifth cervical vertebræ. Several different structures enter into its

composition, such as cartilage, muscle, ligament, mucous membrane, vessels, and nerves, all arranged with no slight degree of complexity, and the student will, therefore, find great assistance by first studying a dry skeleton of the part, before proceeding to the examination of the recent larynx. In giving a description of this organ, we will pursue what would appear to be the natural course, by first commencing with the cartilages and ligaments, and afterwards proceeding to the consideration of the muscles, and openings of the tube.

The larynx consists of eight cartilages, of which four are large, viz., the thyroid, cricoid, and two arytenoid; and four small, viz., two cornicula, and two cuneiform. There is also a fibro-cartilage called the epiglottis, which will be described in its proper place.

Thyroid Cartilage.—Situated at the superior and anterior part of the tube, is said to be shield-shaped, but its resemblance to a saddle is much more striking; it is divided into two alæ or wings forming the sides, an angle or body situated in front, and four cornua, called from their position superior and inferior. Each ala is somewhat quadrilateral, presenting on the external surface two tubercles, sometimes united by an oblique ridge, the superior situated in front of the base of the upper cornu, and the inferior, smaller, one-third from the posterior edge; to the lower margin of the intervening ridge, the sterno-thyroid is attached; and to the superior, the thyro-hyoid, while the inferior constrictor takes its origin from both tubercles, as well as from a ligamentous arch stretched between them; occasionally, also, two foramina are seen, for the transmission of the superior laryngeal nerve, and artery, but this is by no means constant in its occurrence. Both alæ unite in front in the mesial line to form the angle or body, which is more prominent above than below, and larger in the male and adult than in the female or child, its greatest development being coincident with the increase of gravity in the voice. The prominence alluded to, is generally known as the pomum Adami, and is covered by the skin, fascia, with a bursa to facilitate the movements of ascent and descent, and occasionally by an ascending slip of the thyroid body. The posterior edges, rather thick and rounded, are separated from each other to some extent, and enveloped in mucous membrane, beneath which the fibres of the stylo-pharyngeus are inserted. The superior margin, thin and convex, and forming a notch above and anteriorly, when taken in conjunction with its fellow, receives the insertion of the stalk of the epiglottis, while the thyro-hyoid membrane is attached to it, from that point to the base of the superior cornu. The inferior border, thicker than the superior, presents three arches; the largest being in the middle, forming the superior boundary of the crico-thyroid space, and giving attachment to the crico-thyroid membrane; this is limited on

each side by the inferior alar tubercles, behind which, the edge is again excavated to form a smaller arch on each side, overhanging the cricoid cartilage, and receiving the anterior and middle fibres of the crico-thyroid muscle. The superior and inferior cornua spring from the posterior edge above and below, the former being long, cylindrical, and curved inwards, and having attached to it the thyro-hyoid ligament, and the stylo- and palato-pharyngei muscles; while the latter, shorter than the other, but thicker and flatter, and also curved forwards, articulates internally and anteriorly by a plane surface with the side of the cricoid cartilage, giving attachment anteriorly to the posterior fibres of the crico-thyroid muscle, and externally to the inferior constrictor, which partially conceals it. If we now direct our attention to the posterior or inner surface of the angle, or pomum Adami, we first observe the stalk-like process of the epiglottis, attached the highest up, and below it the superior vocal chords, while external and inferior to these, are the thyro-arytenoid muscles, and the inferior vocal chords. The internal surface of the ala corresponds from above downwards to the aryteno-epiglottidean folds of mucous membrane, containing Hilton's muscles, superior vocal chord, thyro-arytenoid muscle, sacculus and ventricle of the larynx, inferior vocal chord, external to which is situated the crico-arytenoideus lateralis, and, more posteriorly to the external angle of the arytenoid cartilage and mucous membrane, with the descending branch of the superior laryngeal nerve.

In the child this cartilage is very small, nor are the alar tubercles developed until after puberty, previous to which the surface is smooth, and the whole structure diaphanous. At the time of the maximum development of the male, or the thirty-first year, those tubercles display an opaque appearance from ossific deposits; and up to a late period of life, it is only that portion of the cartilage below and behind the oblique ridge, which becomes continuously osseous. In the anterior portion, a point or two may be visible at forty years; but after that age the upper and lower edges, as well as the angle, exhibit well-formed plates, and between these other intermediate plates may pass through the ala, uniting the upper and lower margins; but in the ala a continuous osseous layer is never seen, even in advanced life. From the remark, that the development of this cartilage occurs rapidly at the period when the voice is assuming a grave tone, it might be inferred that this gravity depended on the magnitude of the cartilage, but it will be constantly observed that persons having an excess of development in this situation exhibit frequently a peculiar weakness of voice, and high pitch of tone. The superior cornua are occasionally observed to be merely articulated with the ala,—a condition which we have seen in a subject aged thirty-five years,—

but the inferior cornua are a growth or prolongation from the ala itself, and therefore they are not at any period movable.

Cricoid Cartilage.—Annular or oval in shape, the cavity which it circumscribes being greater antero-posteriorly than transversely, is situated between the thyroid cartilage and the trachea, forming the most fixed portion of the larynx. The lower edge, horizontal, thin, and occasionally irregular, is attached to the first tracheal ring by elastic tissue, mucous membrane, and muscular fibres, the latter only at the posterior part, while the upper margin is cut off obliquely from above and behind, downwards and forwards, in such a manner, that the posterior surface is at least five times greater in vertical extent than the anterior, which is a little more than a quarter of an inch. Looking at the superior edge in the middle line posteriorly, a small notch is seen, bounded by two tubercles on either side; the notch being covered by the transverse arytenoidei, and mucous membrane; and the tubercles on either side forming the commencement of the articulating surface for the arytenoid cartilages, to which we have seen attached, in many subjects, longitudinal arytenoid muscles, and often an origin of the inferior constrictor; the articulating surface for the arytenoid cartilage, observed more externally, is convex, and looks upwards, forwards, and outwards, its long axis being directed downwards, forwards, and outwards; while anterior to it, the crico-arytenoideus lateralis muscle arises; and still farther forward, it is excavated for about three-quarters of an inch in width, where it gives attachment to the crico-thyroid ligament, and bounds inferiorly the crico-thyroid space. If we now direct our attention to the circumference, we will find it to be covered anteriorly by the integument and fascia, with a slip of the thyroid body usually lying a little to one side of the middle line: more externally, the convex surface gives attachment to the crico-thyroid muscle; still more externally, on a prominent angle, an oval, planiform, articular facette, looking backwards and outwards, receives the inferior cornu of the thyroid cartilage, and from this a ridge leads vertically downwards, giving origin to the lower fibres of the inferior constrictor, the facette and ridge separating the lateral from the posterior segment of the cricoid; the posterior surface is marked by a median vertical ridge, to which the longitudinal fibres of the œsophagus are attached, while on either side of it is a concavity, giving origin to the crico-arytenoidei postici. The internal surface of this cartilage is smooth and lined by mucous membrane, continuous with that of the larynx above, and that of the trachea below.

The cricoid is much denser and heavier than the thyroid, compensating by its great height posteriorly for the deficiency of the thyroid in that direction; it likewise forms the basis of the tracheal tube,

and the most active of the laryngeal muscles are attached to it, as to their fixed point. Ossific changes occur at a later period in this than in the thyroid, and are principally found in the situation of the origin of the crico-thyroid muscle, and in the median vertical ridges, posteriorly and laterally. The cavity of the cricoid is also somewhat larger in calibre than the first ring of the trachea, and hence it receives it in the quiescent state, and in some rare instances the lower edge is fused with that ring, but a circular indentation always marks their original line of division.

Arytenoid Cartilages.—Are two in number, of a triangular figure, with the base below resting on the cricoid, and apex above surmounted by the cornicula; an oblique concavity found on the base, is for the purpose of articulating with the facette on the upper edge of the cricoid, while the apex is curved backwards, being sometimes united immovably with the cornicula, but more frequently an articulation occurring between them. As it lies in its natural position, it presents three surfaces, viz., an external, an internal, and a posterior or superior, separated from each other by corresponding margins, of which the anterior, looking forwards and outwards, gives attachment to the crico-arytenoideus lateralis, and mucous membrane, which here contains numerous glands, called arytenoid. The inner edge corresponds to its fellow of the opposite side, while the posterior and external presents nothing remarkable except at its termination inferiorly, where it juts out into a tubercle for the insertion of the crico-arytenoideus posticus, and gives origin to the transverse arytenoid muscles. Of its surfaces, the anterior and internal, feebly marked above, but more apparent below, gives attachment from above downwards to the aryteno-epiglottidean folds, and muscles, superior vocal chord, and thyro-arytenoid muscles, while still more inferiorly, a remarkable process called the manubrium, prolonged from it, gives attachment to the inferior vocal chord. The external surface corresponds simply to the ala of the thyroid cartilage, while the posterior superior looks backwards and upwards, is broad and concave, and covered by the arytenoid muscles, and mucous membrane.

Cornicula, or Capitula of Santorini, are two small pyramidal cartilages, directed inwards and backwards, generally moveable on the arytenoid, and rarely fixed, surrounded by the aryteno-epiglottidean folds of mucous membrane, and a few fibres of the epiglottidean muscles.

Cuneiform Cartilages.—These small bodies are found in the aryteno-epiglottidean folds, just in front of the cornicula, but they are sometimes absent, when a reddish mass occupies their usual situation; when removed from their position, it is difficult to free

them from the investing areolo-fibrous tissue, which has led many authors to mistake their natural figure, and it is only after maceration for a short period that a correct opinion can be formed of their shape, which is prismatic, with the base above, and the long axis directed from before backwards.

EPIGLOTTIS.—A fibro-cartilage, situated above, and in front of the glottis, and when examined before any dissection, it appears to be triangular, but on tracing it to its inferior attachment, it is leaf-shaped in figure. It is properly divisible into two portions,—the superior, free, and shaped like the mouth of an ewer, concave on the lingual surface in the vertical direction, and convex transversely, while it is the opposite on the laryngeal surface; the inferior or fixed portion is stalk-like, and attached below to the notch in the upper angle of the thyroid cartilage (thyro-epiglottidean ligament). The epiglottis is connected above to the base of the tongue by three folds of mucous membrane (glosso-epiglottidean), the mesial being the largest of the three, and called the frænum epiglotiddis, a yellow elastic lamina also acting as a bond of union in this situation; anteriorly it is attached to the concave surface of the os hyoides by mucous membrane, areolar tissue, and two yellowish fatty bodies, the so-called epiglottidean glands, and, in addition to these, by some bands of fibrous tissue (hyo-epiglottidean ligaments); and posteriorly, to the arytenoid cartilages, by the aryteno-epiglottidean folds of mucous membrane. In the adult the epiglottis is wide, and notched at the point, but in the child narrow and much compressed laterally; it consists of fibro-cartilage, and is covered by a fine mucous membrane, the laryngeal surface of which is studded with numerous foramina, the openings of glands which are simple in structure, and have no communication with the so-called epiglottidean gland. The principal use of this structure is for the purpose of defending the irritable surface of the glottis from contact with the food in its passage; in man it is a passive organ, depending for its motions on the parts to which it is attached, and in deglutition, when the larynx is raised and the tongue retracted, it is forced over the glottis like a coverlid; in the quiescent state the opening is much smaller than the epiglottis, and the disparity much greater when that opening is contracted, as during the passage of any matter into the pharynx. Except during deglutition, its position is always vertical, so as to leave the glottis free, but still it is with difficulty seen in the living subject. When, however, the finger is passed over the base of the tongue, should any attempt at vomiting be induced, it under all conditions becomes perfectly evident to the touch. In children the glottis can always be reached by the finger introduced

from the mouth, and if during the attempt the epiglottis be rubbed even roughly, it does not excite coughing or spasm, so distressing to the adult, but the moment the margins of the glottal opening are touched, the greatest suffering is excited; still as far as we could observe in a case where we had occasion to pass the finger downwards to the glottis of a child, it did not appear to exhibit the same irritability either in intensity or continuance that manifests itself in the more advanced period of life, under the influence of contact of foreign matter, but whether the parts were at the period in question clothed with mucous, and so shielded from the impression of irritation, we are not certain, and additional observations would, therefore, seem requisite to determine the question, which appears to be of some interest physiologically.

Glottis.—This opening into the larynx, broad anteriorly and narrow posteriorly, is bounded in front by the epiglottis, which forms the curved base, with the concavity directed backwards; posteriorly by the arytenoid cartilages, their cornicula, and a notch which lies between them, and laterally by the aryteno-epiglottidean folds of mucous membrane, which are lax, and contain a quantity of loose areolar tissue, permitting of extensive effusion in œdema glottidis. It was formerly supposed that during deglutition the epiglottis is thrown down upon this opening, completely closing it against the entrance of foreign bodies of all kinds, but at present it is believed that of certain ingesta, especially in the fluid form, some may be introduced into the mouth and swallowed, without it necessarily following that the epiglottis shall cover the aperture at the same time; under ordinary circumstances it is however always in the erect position, so as to favour the free admission of atmospheric air.

Muscles.—May be divided into three sets,—two pair anteriorly, crico-thyroid, and thyro-arytenoid; two pair posteriorly, crico-arytenoideus posticus, and proper arytenoid, and three pair laterally, crico-arytenoideus lateralis, aryteno-epiglottideus, and Hilton's muscles, to which may be added the hyo- and thyro-epiglottideus.

Crico-thyroid.—Triangular in shape, arises from a convex eminence on the side of the cricoid cartilage; the fibres pass upwards and backwards, and are inserted into the inferior edge, and cornu of the thyroid cartilage.

Relations.—It lies on the cricoid, and thyroid cartilages, and crico-thyroid articulation, and is covered by the sterno-hyoid, superior thyroid artery, lateral lobe of the thyroid body, and the edge of the inferior constrictor, which arches over it, the crico-thyroid membrane lying betweeen the two muscles of opposite sides.

Action.—To approximate the anterior edge of the cricoid, and thy-

roid cartilages, thus making tense the vocal chords, by increasing the distance between their points of attachment.

By now cutting vertically the ala of the thyroid cartilage half-an inch external to the angle, and turning it backwards, both the thyro-arytenoid, and the crico-arytenoid lateralis will be brought into view.

THYRO-ARYTENOID.—Narrow behind, but broad and fleshy in front; arises from the posterior surface of the angle of the thyroid cartilage, and passing backwards and outwards, is inserted into the external and anterior side of the arytenoid.

Relations.—Externally, it corresponds to the ala of the thyroid cartilage; internally, to the superior vocal chord; below, to a triangular space, which separates it from the crico-arytenoideus lateralis, and above, to Hilton's muscle; sometimes this muscle is divided into three or four bands, with cellular intervals between them, but we have never seen it so low down as to be in contact with the inferior vocal chord, nor the insertion prolonged into the manubrium, as stated by some.

Action.—To draw downwards and forwards the arytenoid cartilages, as well as to approximate them, thus diminishing the rima by their contraction, and hence they may force the superior vocal chord into the cavity, and render it more prominent, but they certainly can exert little influence in modifying vibration. Explicable by their anatomical position with reference to the vocal chords, we consider them functionally as a part of the lateral crico-arytenoid, assisting them in drawing forwards the outer edge of the arytenoid cartilages, and by this means approximating the manubria and vocal chords, and in this manner contracting the lateral diameter of the rima.

CRICO-ARYTENOIDEUS LATERALIS.—Triangular in shape, with the base above and behind, and apex below and before, and much thicker than the thyro-arytenoid muscle; arises from the upper and outer edge of the side of the cricoid cartilage, and passing upwards and backwards, is inserted into the external edge of the base of the arytenoid cartilage.

Relations.—Externally, it is covered by the crico-thyroid muscle, and the thyroid cartilage; internally, it is in contact with the true vocal chord, and mucous membrane; its lower edge corresponds to the superior margin of the cricoid cartilage, and its upper to a triangular interval, separating it from the thyro-arytenoid.

Action.—To draw downwards and forwards the arytenoid cartilage; to rotate the base so as to turn the manubrium inwards, and to approximate the superior to the inferior vocal chord.

CRICO-ARYTENOIDEUS POSTICUS.—Oval or diamond-shaped; arises

from the depression on each side of the posterior vertical ridge on the cricoid cartilage, and passing obliquely upwards, outwards, and forwards, is inserted by a tendon into the outer angle of the base of the arytenoid cartilage.

Relations.—It lies on the cricoid cartilage, and crico-arytenoid articulation, and is covered by the mucous membrane; it is separated from its fellow by the median ridge, and the longitudinal fibres of the œsophagus, and corresponds externally to the origin of the inferior constrictor, and inferior laryngeal nerve.

Action.—To draw backwards and outwards the arytenoid cartilage, thus producing tension of the vocal chords, and at the same time dilating the rima glottidis in all directions.

Proper Arytenoid Muscles.—Are placed on the superior and posterior surface of the arytenoid cartilages, immediately beneath the mucous membrane, and consist of two layers, the superficial of which are flat bands arising from the base of one cartilage, where they are sometimes attached to the upper edge of the cricoid, and inserted into the apex of the opposite, while in connexion with, but superficial to them, a distinct band for each side is not unfrequently seen arising from the upper edge of the cricoid, and passing upwards and forwards, is inserted into the cornicula of the same side, or this arrangement may be found on one side only, or sometimes the band may be continuous with the posterior arytenoid muscle. The transverse arytenoid consist of two sets of fibres, the one superficial, extending between the distal edges of opposite cartilages, and the other deep between their proximal, running from base to apex.

Relations.—They are covered by the mucous membrane, and lie on the arytenoid cartilages.

Action.—The oblique fasciculi if not acting in concert with the crico-arytenoideus lateralis, approximate directly the cartilages, while the transverse at the same time rotating their bases, tend to separate, and not approximate, the vocal cords. It must however be borne in mind, that certain high authorities attribute an action exactly the contrary to the fasciculi of this muscle.

The Aryteno-epiglottidean Muscles, should be examined by cautiously dissecting off one layer of the aryteno-epiglottidean folds. They are always found with great difficulty, unless the larynx is quite recent, and are divided into the inferior and superior, the former, described by Mr. Hilton, arising narrow from the edge of the arytenoid cartilage, above the superior vocal chord, and passing forwards and outwards, then expands, and is inserted into the side of the base of the epiglottis, having the sacculus laryngis internal to it, and a layer of mucous membrane external to it.

Action.—To compress the sacculus laryngis ; but we cannot conceive it to be a separate muscle, as it is so frequently united with the thyro-arytenoid.

The SUPERIOR ARYTENO-EPIGLOTTIDEUS, consists of a few fibres arising from the apex of the arytenoid cartilage, and passes forwards along the sides of the glottis, to be inserted into the margin of the epiglottis. It is sometimes altogether absent, and even when present, is so pale and confounded with the sub-mucous tissue, that it easily escapes observation.

Action.—Simply to constrict the glottis.

The superior aperture of the larynx having been already described, to examine the inferior, the first ring of the trachea must be removed by a transverse section, when the lower edge of the cricoid cartilage will be seen to circumscribe the outlet, which is oval in shape, with its long measurement from before backwards. The margin of this cartilage is beveled off on the internal surface, and although lined by mucous membrane, it permits the first ring of the trachea to glide within it, during the quiescent condition of that tube. On measuring the vertical distance between the tracheal and glottal orifices, it will be found to be about one inch behind, and an inch and a half in front, the difference depending on the obliquity of the glottis, which slopes from above and in front, downwards and backwards. If a section be now made through the vertical ridge of the cricoid cartilage, and the sides separated, the vocal chords will be seen, two in number on each side, known as the superior or false, and the inferior or true; of these the superior, thin and curved, with the convexity looking upwards, is attached behind to the arytenoid cartilage ; and in front to the back part of the angle of the thyroid; they are covered on both surfaces by mucous membrane, and the handle of a scalpel can be passed upwards on their external side from the ventricle, showing the existence of a pouch, which in some cases extends upwards even to the aryteno-epiglottidean folds of mucous membrane, constituting the sacculus laryngis, which is overlapped externally by Hilton's muscle, and the ala of the thyroid cartilage. The inferior vocal chord, thick, strong, and round, is attached posteriorly to the manubrium of the arytenoid, and passes horizontally forwards to be connected to the angle of the thyroid, close to its lower edge. If the mucous membrane is now carefully dissected from these ligaments, as well as from the stock of the epiglottis, it will be seen that all those structures are continuous with each other, and composed of elastic tissue with parallel fibres, which are few and weak in the superior cord, but numerous and forming a strong prismatic cord in the inferior. Lying between the two chords, the ventricle is seen, semilunar in shape, being curved above, but

straight below; while from its superior and anterior part, the sacculus proceeds, and in this situation a foreign body may lodge, and be wholly uninfluenced by the column of air as it either enters or leaves the larynx. The cricoid cartilage may now be separated from the thyroid, leaving, however, a thin ring of the former superiorly, to support the bases of the arytenoid, and in this manner a view may be obtained of the rima glottidis.

Rima Glottidis.—This constricted space is situated midway between the glottis, and tracheal opening, and in figure closely resembles the ace of spades on playing-cards. It commences posteriorly, between the manubria of the arytenoid cartilage, and this portion which is extremely narrow, after extending for about the posterior third of the space, unites with the anterior which is triangular, with its base behind curved, the convexity looking backwards, and the apex anteriorly, but rounded or blunted. This aperture is bounded in front, by the angle of the thyroid cartilage; behind, by the bases of the arytenoid, and upper edge of the cricoid; and laterally, by the true vocal chords; it is subject to extreme variations in size and figure during the varied intonations of the voice, and also during respiration, being widely dilated during inspiration, and contracted whilst expiration is being performed. Above this opening, the false vocal chords project for a short distance into the laryngeal cavity; but it is quite absurd physiologically to consider that they are of any great importance in connection with the larynx. The mucous membrane, fine, pale, and soft, and covered in its entire extent by ciliated epithelium, loosely adherent at the superior opening, but on descending further within the cavity its attachment to the cartilages becomes very intimate, and hence, while œdema is of constant occurrence in the neighbourhood of the glottis, it is exceedingly rare below that point.

Ligaments of the larynx, consist of the broad, and round thyro-hyoid, the crico-thyroid, crico-arytenoid, thyro-arytenoid, and the inferior, or tracheal ligament.

The broad Thyro-hyoid Ligament is composed of yellow elastic tissue attached inferiorly to the upper edge of the thyroid cartilage, and superiorly to the upper and posterior edge of the os hyoides; it is pierced by the superior laryngeal nerve and artery, and an oval bursa separates it from the posterior surface of the os hyoides; it is covered by the sterno- and thyro-hyoid muscles, and is strong in the middle line, but weak at the sides, where it becomes continuous with the following:—

The round Thyro-hyoid Ligament arises from the superior cornu of the thyroid cartilage, and is attached above to the point of the cornu of the os hyoides; it is composed of dense white fibrous tissue, and a sesamoid bone sometimes exists in it inferiorly. The

round ligament gives attachment to some of the fibres of the middle constrictor.

Anterior Crico-thyroid Ligament, broad and diamond-shaped; strong in the mesial line, but becoming weaker externally, is attached above to the thyroid cartilage, and below to the cricoid. It is covered by the sterno-hyoid, and crico-thyroid muscles, and by the crico-thyroid artery, and is principally made up of elastic tissue. In this space the operation of laryngotomy is performed.

Lateral Crico-thyroid Ligaments.—A strong but imperfect capsule surrounds the articulation of each inferior cornu of the thyroid with the side of the cricoid cartilage, the fibres being strongest posteriorly, while anteriorly a flat band, formed of elastic tissue, passes forwards from the inferior cornu to the side of the cricoid; evidently for the purpose, when put upon the stretch, of restoring, by its resiliency, the former cartilage when depressed; the surfaces of the articulation when opened are seen to be quite smooth, in consequence of the distinct synovial lining with which it is provided. The crico-thyroid lies in front of the articulation, the crico-arytenoideus posticus behind it, and the inferior constrictor covers the external surface.

Crico-arytenoid Ligaments, consist of an imperfect capsule, the anterior and posterior fibres being the strongest; a synovial lining facilitates the motions of the articulating surfaces, and a strong band of fibres also may be traced downwards, from the posterior and external angle under the posterior crico-arytenoid muscle, to the inferior cornu of the thyroid cartilage.

Crico-tracheal Ligament, is represented by a plane of elastic tissue, uniting the lower edge of the cricoid cartilage, to the first ring of the trachea; this may be sometimes fibro-cartilaginous, or it may be absent, the first ring being then fused with the cricoid.

Thyro-arytenoid Ligaments have been already described as the vocal chords, as well as the ligaments of the epiglottis, in the description of that part.

The Larynx is supplied by the superior and inferior laryngeal arteries from the thyroids, and by the superior and inferior laryngeal nerves of the pneumogastric; for a description of which, see Nervous and Vascular Systems.

DEEP MUSCLES OF THE FOREPART AND SIDE OF THE NECK,

Consist of three pair in front,—longi colli, recti capitis antici majores, and minores; while those of the lateral region are,—the scaleni antici, and postici. In order to expose them, the deepest layer of the cervical aponeurosis or prævertebral fascia must be

removed, and in doing so, its attachments may be examined. It comes off superiorly from the basilar process of the occipital bone, and passing downwards on the front of the spine, becomes strong and dense inferiorly, covering on each side the scaleni, and levator anguli scapulæ, and attached below to the superior costa of the scapula and posterior edge of the clavicle; thus separating the posterior inferior triangle of the neck from the axilla, and constituting the cervico-axillary septum. It is also in intimate connection with the first rib, between the anterior and middle scaleni, and completes, in this situation, the upper boundary of the thoracic wall, where it is pierced by the branches of the brachial plexus in their course to reach the axilla, as well as by the subclavian artery. On these several parts, tubular prolongations are sent, which adhere to and strengthen their structure, thus conferring on them a degree of resistance calculated to avert the injurious effects of tension, to which they are so liable, during extensive movements of the upper extremities. Its physiological relation to the lungs is also of much importance, in protecting these organs from the effects of atmospheric pressure, an office that, from its peculiar resisting nature, it is perfectly adequate to sustain; pathologically considered, the utility of this fascia is also unquestionable, for in the cervical region, it restricts abscess consequent on caries of the vertebræ from becoming diffused amongst the lax areolar tissue of the neck; and in the costal, opposes an effectual obstacle to the passage of scrofulous collections of matter into the thoracic cavity; and when the frequency of glandular diseases in this region is remembered, with their tendency to impinge on and compress important organs in their vicinity, the advantage resulting from such a resisting wall of fibrous tissue will be at once recognised.

Longus Colli.—Narrow and tendinous above, but broad and fleshy below, arises from the sides of the bodies of the three superior dorsal vertebræ, from the stellate ligament, head and neck of the first rib, also from the transverse processes, bodies, and intervertebral substance of the fourth, fifth, and sixth cervical vertebræ. It ascends obliquely upwards and inwards in two fasciculi,—an internal and external, and is inserted tendinous into the forepart of the bodies of the three superior cervical vertebræ.

Relations.—The deep surface rests on the spine; the inner edge is separated from the opposite muscle, by the bodies of the vertebræ and the anterior vaginal ligament below; but superiorly, they converge and conceal these parts; the external margin is separated from the anterior scalenus by the vertebral artery, and inferior cervical ganglion of the sympathetic below, but is closely related to the rectus capitus anticus major above; it is covered by the left subclavian, carotid, and aorta on the left side; and by the arteria

innominata on the right; while in the neck, on either side, the subclavians, the common carotids, and jugular veins, pneumogastric, and sympathetic nerves, the pharynx, œsophagus, and larynx rest on its anterior surface.

Action.—To bend the neck forwards and to turn it on one side; but its principal use would appear to be, to act as a vital ligament in preserving its erect position.

Rectus Capitis Anticus Major, external to the last, arises from the anterior surface of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ by tendinous slips; to these succeed fleshy fasciculi, that unite to form a muscular mass, which ascends obliquely upwards and inwards, and is inserted into the cuneiform process of the occipital bone, which, here, often presents a depression for its reception.

Relations.—Its origin is between the longus colli, and the anterior scalenus; and it rests on the spine, and rectus minor, while it is covered by the pharynx, internal carotid, and jugular vein, pneumogastric, superior laryngeal, pharyngeal, and sympathetic nerves, with the ascending pharyngeal artery, and vein.

Action.—To depress the head, and bend it forwards.

Rectus Capitis Anticus Minor.—In order to see this muscle, the rectus major, under which it lies almost directly, must be raised and drawn inwards. It is somewhat square in shape, and arises from the anterior half-arch of the atlas, between the anterior crest, and the rectus capitis lateralis. The fibres pass upwards and inwards, and are inserted into the cuneiform process, posterior and external to the rectus major, a depression likewise existing a little posterior to the last, for its insertion.

Relations.—It lies on the occipito-atlantoid articulation, and broad ligament; and is concealed by the last muscle, sympathetic nerve, and jugular vein; the outer margin corresponds to the rectus lateralis, from which it is separated by a triangular space, containing the ninth and suboccipital nerves, while the inner edge is separated from the opposite, by the cord-like or vertical occipito-atlantoid ligament.

Action.—To draw the head forwards, and to one side; or when both act, to bend it directly forwards.

Scalenus Anticus, triangular in figure, and situated laterally, arises from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sometimes sixth cervical vertebræ, by tendinous, short slips, that soon, however, become fleshy and thick, and pass downwards, forwards, and outwards, to be inserted, by a tendon about half-an-inch in width, into an oblique crest on the upper surface of the first rib.

Relations.—It is covered anteriorly by the sterno-mastoid, omo-hyoid, and posterior surface of the subclavian muscle, subclavian vein, transversalis humeri, and colli arteries, phrenic nerve, and ascending cervical artery, with a strong layer of fascia binding the latter parts to its surface, while it lies on the subclavian artery, brachial plexus of nerves, cervicalis profunda, and superior intercostal arteries, posterior scalenus, and the lower branches of the cervical plexus; the inner edge is separated from the longus colli above by the rectus major; and below, by the vertebral artery, veins, inferior cervical ganglion, and the subclavian trunk; while the external margin is in contact with the trapezius.

Action.—To fix the first rib, and bend the head to one side.

Scalenus Posticus, sometimes considered as two distinct muscles, arises by tendinous slips from the posterior tubercles on the transverse processes of all the cervical vertebræ, except the first and last; the fibres pass downwards and outwards, separating into two fasciculi, which are inserted into a tubercle on the first rib behind the subclavian artery, and also into the upper edge of the second; but this latter attachment is sometimes wanting, a long slender muscular band taking its place, and passing from that rib to the transverse process of the atlas; this may be called the scalenus posticus minor, to distinguish it from a small band that is brought into view by cutting across the anterior scalenus, and throwing it upwards, when a short but broad fasciculus may be observed, arising from the sixth transverse process, and passing downwards and forwards, is inserted into the first rib, separating the subclavian artery, and brachial plexus; this also is very often absent, but when present it may be called scalenus anticus minor.

Relations.—In front it has the anterior scalenus, brachial plexus, and subclavian artery; behind, levator anguli scapulæ, splenius, transversalis colli, and the cervicalis descendens; externally, serratus magnus, sterno-mastoid, and transversalis colli artery; and internally, the first intercostal layer and rib, cervical vertebræ, and intertransverse muscles. It is pierced, by the long respiratory nerve.

Action.—Similar to the last.

DISSECTION OF THE UPPER EXTREMITY.

Directions.—The shoulders of the subject having been raised on a block, and the arms elevated to right angles with the side, make an incision through the integument, from the sternal end of the clavicle to the ensiform cartilage, continuing it backwards on the side of the chest, at right angles to the first; then let another be carried out-

wards along the clavicle, arching downwards and outwards, so as to terminate at the upper third of the arm; the skin may now be reflected, and the following parts are brought into view, viz.:—origin of platysma myoides, descending branches of cervical plexus of nerves, and the superficial fascia.

SUPERFICIAL FASCIA.—A thin sheet of areolo-fibrous tissue, continuous with the similar covering in the contiguous regions, descends from the neck, and passing over the clavicle covers the anterior and lateral parts of the thorax; externally it forms the floor of the axilla; internally it is continuous with that of the opposite side, and below blends with the abdominal superficial layer; thick and well marked superiorly, but thin and indistinct inferiorly, it is occasionally loaded with fat, and especially so in the female; while the absence of fatty deposit in the male, is always accompanied by a more distinct fibrous character, with consequent density and resistance. In the female, it also splits to form a capsule for the breast; and in addition, likewise sends processes (ligamenta suspensoria) into the gland for the support of its internal structures. Between the layers of the fascia, as it passes over the clavicle, are the supra-clavicular branches of the cervical plexus, flat, and like ribbons in appearance, destined for the supply of the thoracic integument; while fused with it superficially, are seen a few scattered fibres of the platysma, constituting a part of the origin of this muscle, with likewise some minute ramusculi of the thoracic arteries. If the fascia is now raised, the great pectoral is at the same time exposed.

PECTORALIS MAJOR.—Triangular in shape with the base at the sternum, and apex at the humerus, arises by short tendinous fibres from the sternal half of the anterior edge of the clavicle, which is sometimes grooved; from the cartilages of the second, third, fourth, and fifth ribs, and also from the cartilage and bone of the sixth, these origins being fleshy on the superficial, but tendinous on the deep surface; from the anterior and outer edge of the sternum, and by an aponeurosis that covers the anterior surface of that bone, the fibres of opposite sides here decussating obliquely; from these several origins the fibres pass in different directions, the clavicular downwards, backwards, and outwards; the costal obliquely upwards, backwards, and outwards; and the middle, or sternal, outwards and backwards; all ultimately converge, and are inserted into the anterior and outer lip of the bicipital groove, the clavicular passing to the most inferior and anterior part of the tendon, while the costal and sternal portions are twisted upwards and backwards behind them, so as to lie on a plane superior and posterior to them, the tendon likewise participating in this twisted arrangement. We have once seen a long flat muscular band arising from the external

insertion of the reetus, pass upwards on the serratus magnus, and then winding beneath the eostal fibres of the great pectoral, unite with the superior and posterior edge of the tendon of the latter muscle.

Relations.—The upper and outer edge, eorrespond to the deltoid, from which it is separated by a triangular interval (Deltoid Groove), occupied by the eephalic vein, the thoraeica humeraria artery, lesser pectoral, subelavius, infra-aeromial artery, with a braneh of the anterior thoracic nerve, and at the superior part, the point of the coraeoid proeess; the inferior margin, forms the anterior fold of the axilla; anteriorly, it is eovered by the integument, superfieial fascia, with origin of platysma, and mammary gland; it is also overlapped inferiorly, by the anterior edge of the deltoid, from which the tendon is separated by a bursa, to diminish friction during contraction, and it lies on the elavicle, sternum, ribs, intereostals, lesser pectoral, serratus magnus, axillary vessels, and nerves, eoraeo-braehialis and bieeps muscles.

Action.—It will be observed that the elavieular, sternal, and costal fibres, are distinet and separated by cellular spaces, but still the muscle can only act as a whole to press the arm to the side, or if the arm be fixed, it elevates the ribs in foreed inspiration; by presenting a soft eushion it protects the superior ribs from fracture, and by the proximity of its insertion to the head of the humerus, it would apparently serve to avert disloeation, not to produce it.

By eutting across the last muscle, and cautiously refleeting it, the following parts are brought into view, viz., superior thoraeie artery, lesser peetoral musele, the ligamentum bieorne, the bieeps, coraeo-braehialis, and axillary vessels, and nerves.

Pectoralis Minor.—Triangular in shape, broad and expanded at its origin, and narrow at its insertion, arises by short aponeurotic fibres, which soon give plaee to three fleshy slips from the third, fourth, and fifth ribs, external to their eartilages; the fibres pass upwards, baekwards, and outwards, and end in a tendon whieh is inserted into the internal and anterior edge of the coraeoid proeess. A thin slip passes off from its lower margin, to bind down the bieeps, and coraco-braehialis, and to assist in forming the fascia on the inner side of the arm; while a seeond prolongation, eontinued over the eoracoid proeess, passes through an aperture in the triangular ligament, and becomes eontinuous with the supraspinatus tendon, but this, however, is sometimes absent.

Relations.—The upper margin, forms the inferior boundary of the space in which the axillary artery lies in its first stage, and gives attachment to the expansion of the ligamentum bicorne, which in return sends a thin layer over the anterior surfaee of the musele; while

the lower margin projects below the great pectoral. It is covered by the great pectoral, the superior thoracic artery, and the anterior thoracic nerve; and it lies on the ribs, intercostal muscles, serratus magnus, and axillary vessels, and nerves.

Action.—To depress the shoulder, and draw the scapula forwards and inwards. It also presses the clavicle against the sternum, and thus promotes security, when the shoulders are thrown forcibly backwards; when the scapula is fixed, it may likewise assist in inspiration.

By removing the costo-coraco-clavicular ligament from the clavicle, the small muscle lying beneath that bone will be exposed.

SUBCLAVIUS MUSCLE.—Somewhat round, arises by a short tendon from the cartilage and anterior extremity of the first rib, and immediately becoming fleshy, passes upwards, backwards, and outwards, to be inserted into a groove on the under surface of the clavicle as far out as the interval between the attachments of the conoid and trapezoid ligaments.

Relations.—Anteriorly it corresponds to a layer of the costo-coracoid ligament, and the acromial branch of the thoraccia-acromialis; below, to the axillary vessels, and nerves; and behind, to the subclavian vein, and the transversalis humeri artery, the posterior layer of the costo-coracoid ligament, and insertion of the scalenus anticus.

Actions.—To fix the first rib; to press the sternal end of the clavicle against the sternum, and also to depress the shoulder. The mode in which this muscle is enveloped, by a dense fascial sheath prevents its contraction under ordinary circumstances, from interfering with the circulation in the axillary vessels; but still, by forcibly depressing the shoulder, and contracting the muscle by a voluntary effort, the pulse at the wrist may be rendered almost imperceptible.

The student should now remove the fat, areolar tissue, and glands from the axilla, referring for the description of its contents to the VASCULAR SYSTEM,—and having done so, let him saw across the clavicle, throw outwards and backwards the arm, in order to examine the following muscles:—

SERRATUS MAGNUS.—A thin, flat sheet of muscle, lying on the anterior and lateral part of the thorax, somewhat quadrilateral in shape, the upper margin being the shortest, and the anterior the longest; arises by triangular slips from the first eight ribs, external to their cartilages, the two first being tendinous, and often united, while the six succeeding are fleshy, and much broader than the others; although these origins appear to advance forwards as they descend, still the inferior slips, from the increasing length of the ribs, are attached, the most remote from the cartilages; the

fibres pass backwards, the superior and middle almost horizontally, but the inferior thick and converging, ascend obliquely, and are inserted into the internal surface of the superior and inferior angles of the scapula, and in the intermediate space between those two points into a strong fascia stretched between them, lying anterior to the rhomboid, and behind the subscapular muscles.

Structural Peculiarities.—This muscle consists of three distinct portions,—superior, middle, and inferior. Of these the superior, triangular, has its base attached to the first and second ribs, sometimes to the second only, and the apex to the superior angle; the middle weaker than the first, and square in shape, is attached anteriorly to the third, fourth, and fifth ribs, and posteriorly to the fascial structure at the base of the scapula; while the inferior, the strongest and most fleshy, and triangular, is attached by its base to the sixth, seventh, eighth, and ninth ribs, and by its apex to the inferior angle of the scapula.

Relations.—The external surface is covered by the pectorals, the axillary vessels and nerves, by the scapular, and subscapular muscles, and by a quantity of lax watery areolar tissue, by the long thoracic nerve, and artery, and by the latissimus dorsi, internal to which it lies; while the internal surface, lies in contact with the ribs, intercostals, and the scapular branch of the posterior scapular artery.

Action.—Acting as a whole, it draws forward the scapula and shoulders; but if the inferior portion acts alone, it rotates the bone so as to elevate the glenoid cavity, thus assisting the trapezius by a reversed action; by fixing the scapula it may also assist in inspiration, thus causing it to act from its insertion to its origin.

The student should now proceed to examine the thorax and its contents, for which the ANATOMY of that cavity should be consulted.

The subject should now be placed on the face, with a block beneath the thorax, and the arms allowed to hang over the edges of the table.

The INTEGUMENT of the BACK is strong and pale, and increases in density as we approach the middle line, where an indentation indicates the union of the opposite sides—the prominent points in this region being, the occipital bone superiorly, the spinous process of the seventh cervical vertebra in the middle, and lower down the spines of the scapula laterally and superiorly, and the crests of the iliac bones laterally and inferiorly. An incision should now be made from the tubercle of the occipital bone downwards, to the base of the coccyx; a second upwards and forwards, to the middle of the crest of the ilium; and a third downwards and outwards, from the occipital bone to the external third of the clavicle; when the integument may be reflected

forward, and the superficial fascia exposed. This latter structure, dense above, but lax and loaded with serosity inferiorly, is permeated in all directions by the cutaneous filaments of the cervical, dorsal, and lumbar nerves, and when it is removed the trapezius and latissimus dorsi are brought into view, constituting the first of the four layers found in this region.

TRAPEZIUS.—Triangular in shape, with the base at the spine, and apex at the clavicle and scapula; arises by thin aponeurotic fibres from the internal third of the superior curved line on the occipital bone, from the ligamentum nuchæ, from the spinous process of the last cervical vertebra, and from similar points of all the dorsal, and supraspinous ligaments. The superior fibres pass downwards, forwards, and outwards; the middle directly outwards; and the inferior upwards, forwards, and outwards; the lower portion ends in a thin tendon, which, gliding over the commencement of the spine of the scapula, from which it is separated by a bursa, and a layer of stratiform cartilage, is inserted tendinous into the upper edge of the spine of the scapula, and posterior margin of the acromion; while the superior is attached to the posterior edge of the external third, or sometimes half of the clavicle, being united in the latter case to the posterior border of the sterno-mastoid. The occipital attachment, is thin and intimately adherent to the integument; while the cervical is tendinous, and forms an aponeurosis called the cervical, a structure oval in figure, and attached in the middle line to the ligamentum nuchæ, and to the spinous processes from the fifth cervical to the third dorsal vertebra; while its edges are blended with the fleshy fibres of the muscle; the dorsal origin of the trapezius, also tendinous, is pierced by small twigs of the intercostal cutaneous arteries, as well as by cutaneous filaments of the posterior dorsal nerves, but at some distance in front of the tendinous origin.

Relations.—It is covered by skin and fascia, and lies on the complexus, splenii, levator anguli scapulæ, rhomboids, latissimus dorsi, and supraspinatus muscles; on the occipital artery, and great occipital nerve, which pierce it in this region; on the spinal accessory nerve, which enters its anterior edge, but above the clavicle; and also on the transversalis humeri, and colli arteries.

Action.—To raise the shoulder and draw it backwards, or to draw downwards and to one side the occipital bone; or, both acting together, to forcibly pull the head backwards.

LATISSIMUS DORSI.—Triangular in shape, with its base at the spine, and apex at its humeral insertion; arises by short tendinous fibres from the spines of the six inferior dorsal, and all the lumbar vertebræ, from the spines of the sacrum, from the posterior third of the crest of the ilium, and by triangular slips, which indigitate with similar

origins of the external oblique, from the three last ribs, near their anterior extremities. The superior fibres, pass horizontally outwards; the middle and inferior, with different degrees of obliquity, upwards and outwards; the muscle then becomes contracted, but still preserving its flattened form, glides over the inferior angle of the scapula, from which it sometimes derives an origin, or from which it may be separated by a bursa; it next lies on the posterior surface of the teres major, and then twisting round its inferior margin to reach its anterior surface, forms a flat tendon, which is inserted into the posterior edge of the bicipital groove, and by a continuation, into the bone, as far upwards as the lesser tuberosity, but above and in front of the teres major, from which it is separated by a bursa.

Relations.—It will be observed that this muscle is attached to the lumbar, and sacral vertebræ by an aponeurotic expansion, narrow above, but broad below, and firmly adherent to the spines of the vertebræ, and sacrum; and laterally, to the posterior fifth of the crest of the ilium; while above and externally, it is continuous with the fleshy sheet of muscle, which is covered by skin and fascia, by the cutaneous filaments of the posterior lumbar nerves, and by the trapezius; in the axilla, by the axillary artery, vein, and brachial plexus, by the coraco-brachialis, and biceps, which lie on its tendon, and which separate it from that of the great pectoral, although still they are connected by a dense aponeurosis, one layer of which sinks into the bicipital groove to line it, while the other passes over the long tendon of the biceps, and binds it down in its natural position. As the trapezius, and latissimus dorsi diverge, as they approach the base of the scapula, there results a triangular space in this situation, varying in size according to the muscularity of the individual, bounded above by the trapezius, and below by the latissimus dorsi, with the base externally formed by the scapula. In this are seen, when a thin fascia is removed, the inferior fibres of the rhomboideus major, tendinous slips of the sacro-lumbalis, and the seventh, eighth, and ninth ribs, with their attached intercostals, as well as the terminating branches of the posterior scapular artery. The anterior or abdominal edge of the latissimus dorsi, corresponds between the last rib and the crest of the ilium, to the posterior margin of the external oblique, leaving however a triangular space in this situation, with the apex above and base below, where a portion of the internal oblique, and the iliac branches of the internal circumflex artery, and ilio-scrotal nerve are seen, but instances have sometimes been observed where this space is absent, owing to the fusion of the margins of the two muscles with each other. The latissimus dorsi rests on the sacrum, the longissimus dorsi, sacro-lumbalis, spinalis

dorsi, and serratus inferior muscles, with the posterior dorsal, and lumbar nerves, the ribs, intercostals, and teres major.

Action.—To draw the shoulders downwards and backwards, to rotate the arm inwards, and draw it backwards behind the body, to raise the body as in climbing, and assist in the support of the trunk; it also aids both in expiration and inspiration, as it acts either from its origin or insertion.

The two-last described muscles may now be cut vertically, and reflected outwards and inwards, and this brings into view the second layer, consisting of seven, mutually overlapping each other, viz :—rhomboideus major, and minor, levator anguli scapulæ, splenius, capitis, and colli, and serratus posticus superior, and inferior.

RHOMBOIDS.—The MINOR narrow and thin, arises tendinous from the last cervical spinous process, and ligamentum nuchæ, and passing outwards and downwards, is inserted into the base of the scapula opposite to the spine. The MAJOR, arises from the three superior dorsal spines, and, taking also the same direction, is inserted into the base of the scapula from the spine to the inferior angle.

Relations.—They are covered by the trapezius, a portion of the major being superficial in the triangular space before described, and by the latissimus dorsi; while they lie on the splenius capitis, on the serratus posticus superior, and on the posterior scapular artery, with the insertion of the serratus magnus.

Action.—To rotate the scapula, so as to depress the acromion process, and also to draw backwards the shoulder, thus assisting the trapezius, aud opposing the serratus magnus.

LEVATOR ANGULI SCAPULÆ.—Somewhat round, arises by tendinous slips from the posterior tubercles of the transverse processes of four superior cervical vertebræ; these join the fleshy portion of the muscle obliquely, and it then passes downwards and outwards, to be inserted into the superior angle of the scapula, grasping it as far downwards as the spine of that bone.

Relations.—It lies on the cervical nerves, splenius colli, and scalenus posticus, but separated from the latter by the posterior scapular artery, while it is covered by the trapezius. A triangular space is here visible, bounded above and internally by the splenius capitis, inferiorly and internally by the rhomboideus minor, and externally by the levator anguli scapulæ; through this the posterior scapular artery passes, only covered by the trapezius.

Action.—To raise the base of the scapula, and rotate it, so that the acromion may be depressed; they likewise act in respiration by directly antagonizing the serratus magnus at its point of insersion.

The rhomboids and levator anguli scapulæ should now be cut across, so as to expose the serratus superior, and splenius.

Serratus Posticus Superior.—Arises by a thin aponeurotic expansion from the three superior dorsal spines, and also from the ligamentum nuchæ; it soon becomes fleshy, and is inserted by short slips into the second, third, and fourth ribs, about an inch external to their angles.

Relations.—It is covered by the rhomboids, and lies on the splenii, sacro-lumbalis, and on the posterior intercostals, and ribs. It will be observed, that the lower edge of the tendinous origin of this muscle is continuous, with a fascial expansion (dorsal aponeurosis) that passes downwards, and unites it to the serratus inferior, through which it becomes connected with the lumbar aponeurosis.

Serratus Posticus Inferior.—Arises thin and aponeurotic, from the spines of the three last dorsal, and two first lumbar vertebræ, and passing outwards and upwards, is inserted into the ninth, tenth, and eleventh ribs, external to their angles, likewise by fleshy slips.

Relations.—It is covered by the latissimus dorsi, and lies on the lumbar mass of muscles, ribs, and intercostals.

Actions.—The serratus superior is a muscle of inspiration, its action being to raise the ribs; while the serratus inferior is a muscle of expiration, as by its contraction it depresses them.

Splenius.—Is brought into view by removing the serratus superior. This muscle is usually looked on as two, namely, the splenius capitis, and colli, but as the line of separation is often either totally absent or very indistinct, it is preferable to consider it only as one. It arises from the spines of the two or three last cervical, and the five first dorsal vertebræ, as well as from the ligamentum nuchæ. The fibres pass upwards, forwards, and outwards, and are inserted into the posterior tubercles of the transverse processes of the four superior cervical vertebræ by tendinous slips, also into the outer and back part of the mastoid process, and into the occipital bone between the two transverse ridges.

Relations.—It is covered by the trapezius, sterno-mastoid, and serratus superior; and lies on complexus, a small portion of which is seen above, between the divergent splenii of opposite sides, on the semispinalis colli, the occipital, and cervicalis profunda arteries, and great occipital nerve.

Action.—To bend the head backwards, and rotate it to one side.

The third layer consists of the sacro-lumbalis, longissimus dorsi, spinalis dorsi, cervicalis descendens, trachelo-mastoid, and complexus.

Clothing the posterior and lateral part of the spine, and extending from the sacrum to the last cervical vertebræ, there lies a mass of muscle

composed of tendinous and fleshy fasciculi, to which the term erector spinæ, or sacro-spinalis, has been applied; this mass being divisible into portions lying in contact from without inwards, sometimes capable of being separated with facility, or again so completely fused with each other as to require an artificial division to correspond with any applicable existing description that we are acquainted with. They are, however, usually said to consist of the sacro-lumbalis, the most external; longissimus dorsi, in the middle; and the spinalis dorsi, internally.

Sacro-lumbalis.—Narrow above and below, but wide in the middle, arises by a broad, strong aponeurosis from the tubercles on the back of the sacrum and its transverse processes, from the posterior spine of the ilium, and the posterior fourth of the adjacent crest, and from the spines and oblique processes of all the lumbar, and three inferior dorsal vertebræ. The fibres pass upwards and outwards, and are inserted by flat, tendinous slips into a ridge on the posterior surface of the angle of each rib. If the sacro-lumbalis be now divided from the longissimus dorsi and turned outwards, a series of short aponeurotic and fleshy fasciculi are seen (musculi accessorii), from seven to nine in number, arising from the upper edge of the angle of each rib, and inserted into the corresponding tendons of the sacro-lumbalis.

Longissimus Dorsi.—Lies internal to the last, and arises from a strong aponeurosis, which connects it to the ridge and transverse process of the sacrum, and spines and articular eminences of the lumbar vertebræ; it ascends in the vertebral gutter, and is inserted into the articular eminences of all the dorsal vertebræ, and externally by tendinous fasciculi into all the ribs internal to their angles.

Spinalis Dorsi.—Narrower than the last but more internal, and frequently united to it; arises tendinous from the spines of the three upper lumbar, and two last dorsal vertebræ, and is inserted into the spines of the remaining dorsal.

It has been seen, that these muscles have a common origin from a strong layer of tendon, wide below but narrow above, with the internal margin straight, and firmly attached to the sacral ridge, to all the lumbar, and three dorsal spines; while the external edge, curved and weak, is attached externally to the transverse processes of the sacrum, and posterior superior spine of the ilium; from the upper and outer edge of this aponeurotic expansion the muscles arise;—the fibres being vertical, but at the same time interlaced with oblique bands, which tend to increase their strength.

Relations.—The lumbar mass is covered by the latissimus dorsi, serratus inferior, the posterior leaf of the lumbar fascia, and the posterior lumbar, and intercostal cutaneous nerves. It lies on

the middle leaf of the lumbar fascia, which separates it from the quadratus lumborum, and also on the bones and intercostals.

Action.—To support or generally flex the spine to one side, or to bend the body backwards, and depress the ribs.

CERVICALIS DESCENDENS, or CERVICAL PORTION of the SACRO-LUMBALIS.—Arises from the five superior ribs, between their tubercles and angles, and passing upwards and outwards, ends in four tendons, which are inserted into the transverse processes of the four or five inferior cervical vertebræ, the levator anguli scapulæ overlapping them, and blending with their fibres.

Relations.—It lies internal to the sacro-lumbalis, and is covered by the splenii, levator anguli, and the serratus superior.

Action.—To bend the neck to one side, or support it in the erect position.

TRANSVERSALIS COLLI or CERVICIS, seen by turning outwards the longissimus dorsi, arises from the posterior projecting points of the spinous processes of the third, fourth, fifth, and sixth dorsal, and is inserted into the transverse processes of the five inferior cervical vertebræ.

Relations.—It is covered by the splenius, levator of the scapula, and longissimus dorsi, and lies on the trachelo-mastoideus and complexus.

Action.—Similar to the last muscle.

TRACHELO-MASTOID.—Exposed by reflecting outwards the transversalis colli, arises by four flat tendons from the groove between the articular and transverse processes of the four inferior cervical vertebræ, and, passing upwards and outwards, is inserted into the inner surface of the posterior edge of the mastoid process. This muscle is intersected by an oblique tendinous line about its middle; and we have frequently, when it appeared to be absent, seen it inseparably united to the edge of the complexus.

Relations.—It lies on the complexus, oblique, and digastric muscles, on the mastoid process, and occipital artery; and is covered by the splenius and transversalis colli.

Action.—To rotate the head, or draw it backwards and to one side.

COMPLEXUS.—Tendinous and bifid below, but thick and fleshy above; arises tendinous from the spines of the six superior dorsal, and from the transverse and oblique processes of the four inferior cervical vertebræ; it passes obliquely upwards and outwards, and is inserted into the rough surface of the occipital bone, between the two transverse ridges, internal to the splenius capitis. The internal portion of this muscle is at first fleshy, and then forms a tendon about two inches in length, to which again succeeds a fleshy belly, and hence the name biventer is sometimes applied to it; a second

flat longitudinal tendon lies in the middle of the outer portion, from which an irregular tendinous line passes upwards and outwards; a second digastric fasciculus being, sometimes observed, on the deep surface.

Relations.—It is covered by the longissimus dorsi, trapezius, transversalis colli, and splenius, occipital artery, and great occipital nerve, which pierces the muscle just below its insertion; and it lies on the obliqui, the posterior recti, the vertebral artery, cervicalis profunda, posterior jugular vein, and posterior cervical plexus, which separate it from the spinalis colli.

Action.—To revert the head, or keep it erect; also to rotate the atlas on the axis.

By removing the complexus, the fourth layer is exposed, which consists of nine muscles, namely, semispinalis colli, and dorsi, which together are termed the dorso-cervico-spinalis;—interspinalis, intertransversalis, multifidus spinæ, the obliqui, and recti.

Dorso-cervico-spinalis, consists of a series of tendinous and fleshy fasciculi—the dorsal portions arising from the transverse processes of the six inferior dorsal, and inserted into the spines of the five superior, and two inferior cervical vertebræ; while the cervical consists of six slips, much thicker and stronger than the dorsal, which arise from the oblique processes of the five lower cervical, and are inserted into the spines of all the same vertebræ, except the atlas. This muscle is exceedingly large in quadrupeds, for obvious reasons.

Interspinales, are bands passing between the spines of the several vertebræ; they are double in the neck, absent altogether in the back, and remarkably strong and thick in the lumbar region.

Intertransverse Muscles.—A double plane of muscular fibre, consisting of an anterior, and a posterior fleshy belly attached, as their names imply, and represented between the occipital bone and atlas by the rectus lateralis, with this difference, however, that this muscle is single. In the cervical region, those slips are separated by the vertebral artery, and the cervical nerves; but we never could detect these fibres in either the dorsal or lumbar sections, their substitutes there appearing to be the intertransverse ligaments.

Multifidus Spinæ.—Simply a series of tendinous and fleshy strips, running between the spines, and transverse processes of the vertebræ; the highest arising from the spine of the axis, and inserted into the transverse process of the succeeding vertebræ; a repetition of a similar arrangement ensues as far down as the last lumbar spinous process, the last slip being attached to the transverse process of the sacrum.

Use.—To extend the spine, and produce lateral inclination with rotation.

The RECTI, consist of two muscles on either side, immediately beneath the occipital bone,—namely, the greater, and lesser.

RECTUS CAPITIS POSTICUS MAJOR.—Triangular in figure, with the base above, and apex inferiorly; arises tendinous from the spinous process of the axis; but soon becoming fleshy, passes upwards, backwards, and outwards, and is inserted into the inferior transverse ridge of the occipital bone, close to the mesial line, where an indentation, corresponding to its attachment, is frequently seen.

Relations.—It lies on the atlanto-axoid ligament, atlas, posterior occipito-atlantoid ligament, rectus posticus minor, and occipital bone; and is covered by the complexus. It is separated from its fellow, by the median spine of the occipital bone, and by a deep slip of the ligamentum nuchæ; and corresponds externally to a triangular space, separating it from the superior oblique below, but the latter usually overlaps its insertion.

Action.—To bend the head backwards, and to one side.

RECTUS CAPITIS POSTICUS MINOR.—Also triangular, but much smaller than the last; arises tendinous from the tubercle on the posterior part of the atlas, and passing upwards, backwards, and outwards, is inserted broad, behind the posterior edge of the foramen magnum.

Relations.—It is covered by the complexus, and overlapped by the greater rectus, to which it also corresponds externally; while internally it is separated from that of the opposite side, by the deep process of the ligamentum nuchæ.

Action.—To bend the head backwards.

The student may now examine the ligamentum nuchæ, which is a dense band of fibrous tissue, broad superficially, but becoming thinner as it dips inwards, attached above to the occipital protuberance, and below to the last cervical spine, where it is continuous with the supraspinous ligaments; in the interval between these points it sends slips deeply, which are bifid, to be inserted into the spines of the cervical vertebræ; while the margins give attachment, superficially to the cervical aponeurosis, and more deeply to the cervical muscles.

OBLIQUUS CAPITIS INFERIOR.—Thick, round, and fleshy; arises tendinous from the spine of the axis, and immediately becoming fleshy, passes upwards and outwards, to be inserted into the posterior surface of the transverse process of the atlas.

Relations.—It lies on the posterior intertransverse muscle between the atlas and axis, concealing the vertebral artery; and it is covered by the complexus and trachelo-mastoid, also by the great occipital nerve, which winds round its lower edge to reach the complexus.

Action.—To rotate the head to its own side.

Obliquus Capitis Superior.—Smaller than the last, and somewhat triangular in shape; arises tendinous from the posterior surface of the transverse process of the atlas, and passing upwards, backwards, and outwards, is inserted broad into the inferior transverse ridge of the occipital bone, overlapping the great rectus.

Relations.—It lies on the vertebral artery, occipito-atlantoid ligament, and occipital bone; and is covered by the splenius, and complexus, with the occipital artery.

Action.—To draw the head backwards, and to one side; but it cannot produce rotation.

Between these muscles, a triangular space is observed, bounded above by the superior oblique; below, by the inferior oblique; and the base formed internally, by the rectus major; it is crossed from below upwards and inwards by the great occipital nerve, or posterior branch of the second cervical, beneath which a quantity of fat occupies the depression, and when this is removed the vertebral artery becomes visible with the sub-occipital nerve, which is anterior and inferior to the artery, or nearer to the bone; there is also a branch of connection between the vertebral and occipital arteries, and a venous communication between the vessels, of the same name.

Rectus Capitis Lateralis.—Arises by short tendinous fibres from the upper edge of the transverse process of the atlas for about half an inch; its fibres pass upwards and outwards, and are inserted tendinous and fleshy into the transverse process of the occipital bone, or jugular ridge.

Relations.—Anteriorly, jugular vein and spinal accessory nerve, but the latter is sometimes behind that vessel; posteriorly, vertebral artery and superior oblique; externally, occipital artery; and internally, the suboccipital, and ninth nerves, which separate it from the rectus capitis anticus minor.

Action.—To bend the head on one side.

Having now terminated the description of the dorsal and cervical muscles, we would most strongly recommend the particular attention of the student to be directed to that space bounded behind by the spinous processes of the lumbar vertebræ; above, by the last rib, and inferiorly by the crest of the ilium. As it is probable that the subject has only been dissected on one side, a vertical incision may be carried along the spines of the lumbar vertebræ on the opposite, and a second forwards, corresponding to the lower margin of the last rib as far as its cartilaginous extremity, with a third in a similar direction, along the crest of the ilium, to the anterior superior spine. Thus will be formed the steps requisite to examine the superposition of structures in the lumbar region, the study of which has become of some importance as a matter of practical consideration in connex-

ion with the operations of Callisen, and Amusat, for creating an artificial anus in cases of rectal obstruction, and certain classes of congenital malformation. Accordingly, when the integument is raised from the part alluded to, the superficial fascia is seen, thick and strong behind, and attached in this situation to the lumbar spines, but as it passes forwards, it diminishes in density and thickness, generally assuming the laminated condition peculiar to the abdomen in its structure,—the last dorsal nerve, and posterior branches of the four first lumbar, being here observed passing downwards and forwards, to reach the skin of the buttock. When this layer, with the tendinous origin of the latissimus dorsi, is cautiously removed, the posterior layer of the lumbar aponeurosis, which is intimately blended with the fibres of the last named muscle, is exposed; and if taken as a whole both present in combination an oval figure, attached to all the lumbar spines, to the tubercles on the back of the sacrum, and three inferior dorsal spines internally; to the posterior spinous process of the ilium, part of the adjacent crest, and ilio-lumbar ligament inferiorly, and by short fibrous bands to the last rib superiorly. By a careful dissection, however, it can be shown that the aponeurosis of the latissimus dorsi, if divided perpendicularly, and the posterior portion reflected backwards, can be raised from the proper lumbar fascia to within an inch and a half of the vertebral spines, but behind that point, both the aponeurosis of the inferior serratus, and the latissimus, are inseparably united with the lumbar fascia, the three having, in fact, a common attachment to the vertebræ. It follows therefore, from this description that the posterior leaf of the aponeurosis, must be strongest where it binds down the erector spinæ muscles, which in a perfectly developed subject stand out prominently, and form a rounded longitudinal mass on each side of the vertebræ; and it must, under those circumstances exercise a powerful influence in retaining them in their proper positions, during those violent contractions or sudden movements to which the spine so constantly subserves; but at the outer margin of this mass the proper lumbar layer, although still intrinsically strong, gradually diminishes in resisting power, as it is covered by the fleshy part of the latissimus dorsi. If the posterior layer of the lumbar aponeurosis be now raised from the vertebræ, and thrown outwards, it will be found to be easily detached from the erector spinæ, and even for one inch external to the outer edge of those muscles, owing to the existence of some areolar tissue in the latter situation; while by a careful use of the knife, the structure can still be raised, but not without difficulty to the posterior margin of the internal oblique, to which, as well as the external, it appears to afford an origin.

Structure.—This, the POSTERIOR SHEET, the strongest of the three leaves of the lumbar aponeurosis, consists of fibres that appear to arise as bands from the spines of the vertebræ, and then, expanding as they pass outwards, are bound together by others, which are oblique, vertical, and interlacing—the strong fibrous layer resulting from their union being thick behind and below, but thin above and externally, is pierced by the posterior lumbar cutaneous nerves, and arteries.

By raising the outer margin of the erector spinæ, the MIDDLE LAYER of the lumbar fascia is exposed, much weaker in its character than the posterior, from which it is separated by the lumbar mass of muscles internally, and then by a cellular space, while more externally they are in close apposition. On dissection, it will be seen to be attached to the ilium below, the last rib above, and transverse processes of the lumbar vertebræ internally. When we endeavour to raise it, by dividing its attachment to the transverse processes perpendicularly, and throwing it forward, we find that this separation can only be carried to the outer edge of the quadratus lumborum, or three quarters of an inch external to the erector spinæ.

Structure.—It arises by flat bands from the lumbar transverse processes, and these expanding, are again united by interlacing fibres, which bound externally a series of semilunar spaces between the transverse processes, through which the posterior branches of the lumbar arteries, and nerves escape.

The INTERNAL LAYER, becomes visible by simply removing the quadratus lumborum. It is attached to the lower margin and inner surface of the last rib above, to the crest of the ilium below, and behind to the sides of the bodies of the vertebræ, by a series of loops or arched fasciculi, behind the psoas magnus, and in front of the quadratus lumborum; it gives attachment with the preceding, or middle layer, to the transversalis only, while it is covered behind by the quadratus; and in front by the psoas, lumbar arteries, some branches of the lumbar plexus and last dorsal nerves, with some fatty cellular tissue; and on the right side, for its lower two-thirds, by the ascending colon, and for its upper third by the right kidney; while on the left side the descending colon, and left kidney hold similar relations to it.

Structure.—It consists principally of arched and transverse fibres, remarkable for their strength superiorly, where they form the ligamentum arcuatum externum, which gives attachment to the diaphragm, but gradually becoming weaker inferiorly, except at the point where it is attached to the crest of the ilium. The operation of Callisen, in order to reach the descending colon in the lumbar region, consisted in making a vertical incision along the anterior

edge of the quadratus lumborum; while that of Amussat differs in the fact of the incision being transverse, commencing about two inches above the crest of the ilium, and carried outwards from the anterior edge of the quadratus lumborum, to the midde of that bone. In either operation, it will be necessary to be acquainted with the probable situation of the outer edge of the quadratus, and from repeated examinations, we have found this to lie at a distance of, from two inches and a half to two and three quarters from the spines of the lumbar vertebræ. It should, however, be borne in mind, that the descending colon is often loose and floating below, although perfectly fixed in its two superior thirds, and hence it follows, that the higher the incision is made, so much greater will be the facility with which the intestine may be reached; but instances repeatedly occur where the kidney may lie so low down that a danger of wounding this organ may result from the attempt to open the colon above the inferior third. In performing the operation, however, the parts to be cut through are the following:—integument, superficial fascia, latissimus dorsi, three layers of the lumbar fascia, and some fatty areolar tissue, when the colon is exposed, and, here, generally is uncovered by the peritoneum.

This period of the dissection may also be taken advantage of, for the purpose of examining the proper costal muscles, and in order to accomplish it perfectly, a vertical section should be made through the dorsal vertebræ, and sternum; but we would not, however, advise this course to be pursued at present, as a sufficiently good idea of these muscles may be obtained by simply fracturing the ribs, turning them outwards, and then tearing off the pleura.

The Costal System, consists of levatores costarum, intercostals, infracostals, and triangulares sterni muscles.

Levatores Costarum, consist of twelve pairs of small triangular muscles; each arising from the posterior part of the extreme point of the transverse process of the vertebra above, commencing at the seventh cervical, and terminating at the eleventh dorsal; it passes downwards and outwards, becoming broader as it descends, and is inserted into the rib below, between the tubercle and angle on its upper edge.

Relations.—They are covered by sacro-lumbalis, longissimus dorsi, and serrati, and lie on the external layer of intercostals.

Action.—To elevate the ribs.

Intercostales, consist of twenty-two pairs, or eleven on each side, forming an internal, and external layer; they arise from the margin of the rib above, tendinous, and are inserted into the margins of the rib below, also tendinous; the fibres of the external run downwards and forwards, and those of the internal downwards and backwards.

In the antero-posterior direction, however, the two layers are of equal extent, from the external commencing at the transverse process, or costo-vertebral articulation, and terminating at the cartilage, a strong aponeurotic expansion being afterwards substituted as far as the sternum, and the internal layer commencing at the angle of the rib, and continuing inwards as far as the sternum.

The First Intercostal, is the widest, and more tendinous than any of the succeeding; then there occurs a slight diminution in width, as far as the ninth, and this is most evident posteriorly, where sometimes they are scarcely visible, especially in old age, on account of the descent of the ribs; while the tenth, and eleventh are thick and fleshy, and wide both behind and in front; in the latter situation being frequently continuous with the posterior vertical fibres of the internal oblique.

Relations.—They are covered anteriorly by the great and lesser pectoral muscles, serratus magnus, and the external oblique; and posteriorly by the trapezius, latissimus dorsi and serrati; internally, they are in contact with the pleura, the triangularis sterni, origins of the diaphragm, and with the insertions of the transversalis; while the two layers are separated by the intercostal vessels, and nerves, and a thin layer of tendinous structure.

Action.—The external layer of intercostals elevate the ribs, and are thus muscles of inspiration; while the internal, depress them, and thus subserve to expiration.

Infracostales, vary in number, and are sometimes altogether absent. When they do exist they are merely small fleshy slips that pass from one rib to the other, and are nothing more than superficial portions of the internal intercostals.

Action.—To depress the ribs as in exspiration.

By cutting through the cartilages where they join the ribs, and gently raising them, and then by tearing down the pleura, the following thin muscle is seen,

Triangularis Sterni.—Symmetrical, arising from the base of the ensiform cartilage, and extremity of the sternum; passes upwards and outwards, and is inserted by four fleshy slips into the cartilages of the second, third, fourth, and fifth ribs.

Relations.—They lie on the pleura, and are covered by the internal layer of intercostals, and by the internal mammary artery.

Action.—To depress the ribs.

We may now return to the consideration of the upper extremity, and by raising the integument, which has been already freed before and behind, from the point of the acromion to the middle of the humerus, and by removing the layer of fascia in this situation, the deltoid is exposed.

Deltoid.—So called from its similarity in figure to the Greek letter Δ inverted; is large, thick, and triangular, with the base above and apex below; arises tendinous from the lower edge of the spine of the scapula, from the outer margin of the acromion process, and the anterior margin of the external third of the clavicle; the clavicular fibres pass downwards and backwards; the scapular downwards and forwards; and the acromial at first outwards, and then vertically downwards; they all converge and terminate in a tendon, which is inserted into a V-shaped ridge on the outer side of the humerus, about its centre, an aponeurotic expansion extending downwards as far as the external condyle. Sometimes this muscle is divided into three distinct portions, according to its attachments—acromial, scapular, and clavicular, and by unravelling its structure it may be resolved into from ten to fifteen triangular fasciculi, with their bases above, and their apices below, united by tendinous septa, that ultimately by their confluence form the terminal tendon.

Relations.—It is covered by the origin of the platysma, by a thin layer of fascia derived from the infraspinous aponeurosis, by the supra-acromial branches of the cervical plexus, and the circumflex cutaneous, which pierces the posterior fibres; the posterior edge, the longer of the two, partially overlaps the infraspinatus muscle; while the anterior, shorter and thicker, corresponds to the great pectoral, but having between them the cephalic vein, and the humeral thoracic artery, &c. It conceals and covers the acromion, clavicle, coracoid process, deltoid ligament, origins of biceps, coraco-brachialis, insertion of lesser pectoral, capsular ligament, insertion of external capsular muscles, the two anterior thirds of the infraspinatus, teres minor, and major, the triangular and quadrilateral spaces, with the parts passing through them, the circumflex arteries, veins, and nerve, long and outer head of the triceps, a large bursa, and a layer of fascia and the shoulder-joint; its insertion is embraced by the origins of the brachialis anticus, and the anterior edge of its tendon is separated from the pectoral by a bursa.

Action.—When the arm lies at the side, the action of this muscle would press it more firmly to the glenoid cavity; the anterior fibres draw it forwards, the posterior backwards, and if the arm be slightly raised the whole muscle acting will continue the elevation until the humerus is on a line with the acromion; it also makes tense the brachial aponeurosis. The integrity of this muscle is essential to the security of the joint, a fact proved by the effect of paralysis consequent on stretching or laceration of the circumflex nerve, an accident of this kind causing the head of the humerus to descend, sometimes an inch from the glenoid cavity.

The Scapular Muscles are five in number :—supra-, and infra-spiuatus, subscapularis, teres major, and minor.

Supraspinatus, is covered by a layer of fascia, which with a quautity of fat that varies in amount, separates it from the trapezius. This fascia is attached behind to the base, below to the spine, above to the superior costa of the scapula, and in front it follows the tendon of the muscle, and becomes contiuuous with the capsular ligameut. The muscle is triangular in shape, and arises from the supraspinous fossa, and from the fascia that covers it ; passing forwards, it ends iu a strong tendon that runs beneath the deltoid ligament, and then piercing the capsular ligament, is inserted into the superior of the three facettes on the great tuberosity of the humerus.

Relations.—It is covered by the trapezius, fat and fascia, triangular ligameut, and deltoid, and lies on the bone, the supraspinous artery and uerve, and the syuovial membrane of the joint.

Action.—It strengthens the superior and exterual part of the capsule, raises the humerus, and assists iu rotatiou.

Sir A. Cooper believes this muscle to be the principal obstacle to the reduction of a dislocation into the axilla.

Infraspinatus.—Covered in its posterior two-thirds by a strong fascia, attached to the base behind, to the spine of the scapula above, and below to the intermuscular septum that separates it from the teres minor ; at the posterior edge of the deltoid the fascia splits, and sends a layer on the superficial, as well as the deep surfaces of that muscle ; when the investment, which adheres very loosely, is removed, the infraspinatus is seen, of a triangular figure, arising from the infraspinous fossa, and from the fascia which covers it; the inferior fibres pass obliquely upwards and outwards, aud the superior transversely to terminate in a tendon, which winds beneath the acromion process, and over the capsular ligament, to which it intimately adheres, and occasionally perforates, and is inserted iuto the middle facette on the great tuberosity.

Relations.—It is covered by the deltoid, by the fascia, and a few fibres of the latissimus dorsi; and lies on the bone, capsular ligament, and the inosculation between the circumflexus scapulæ, and infraspinous branch of the suprascapular artery, aud on the iufraspiuous nerve.

Action.—It strengthens the capsule exterually, and rotates outwards, but scarcely possesses any power either to elevate or depress the humerus ; it is generally ruptured in dislocation backwards, on the infraspinous fossa.

Teres Minor, is also covered by a thin layer of fascia, and is somewhat rounded in its outline ; it arises from a ridge on the lower edge of the infraspinous groove, and from the tendinous septum, which

separates it from, and almost inseparably unites it to, the last-described muscle; the fibres pass forwards and outwards, and terminate in a flat tendon, which is inserted into the inferior facette, on the great tuberosity of the humerus.

Relations.—It corresponds posteriorly to the deltoid, latissimus dorsi, and a thin fascia, and anteriorly to the long head of the triceps, and the subscapular artery.

Action.—To rotate the arm outwards, and depress the humerus when raised, and to fix the head of the bone.

Subscapularis.—Triangular in shape, also thick and fleshy; arises by fasciculi, three to five in number, from the subscapular fossa; the fibres pass forwards and outwards, and form a tendon about an inch in width, which is inserted into the lesser tuberosity of the humerus, and the ridge below that point.

Relations.—It is divided into fasciculi by aponeurotic septa, which adhere to the ridges on the scapular venter: the external surface is in contact with the bone, the inner lip of the glenoid cavity, which it grooves below the coracoid process, and also with the synovial membrane of the joint as it pierces the capsular ligament; while the internal corresponds to the serratus magnus, which separates it from the ribs, to the fat, cellular tissue, glands, and vessels and nerves of the axillary space, while the subscapular artery and nerve course along its lower margin.

Use.—To rotate inwards, and strengthen the capsule internally; it is generally ruptured in dislocation into the axilla, and on its subsequent state of reparation, or otherwise, depends the future recurrence of the dislocation (Sir A. Cooper).

Those four muscles just described, are known as the capsular, from their connection with that ligament.

Teres Major.—Wider behind than before; arises from the ovoid space on the inferior angle of the scapula, and, passing forwards and outwards, is inserted into the posterior lip of the bicipital groove by a flat tendon, posterior and inferior to the latissimus dorsi.

Relations.—It is in contact posteriorly, with the latissimus dorsi, deltoid, and long head of the triceps; and anteriorly, with the tendon of the latissimus, the axillary vessels and nerves, and the superior profunda artery: its upper edge is separated from the teres minor by the circumflexus scapulæ, and the posterior circumflex artery, and nerve, by the triangular and quadrilateral spaces, and by the middle head of the triceps.

Action.—To draw the arm backwards and inwards, and probably to rotate inwards also.

DISSECTION OF THE ARM.

Throw down the integument from the back and front of the arm; but at the bend of the elbow, be careful to avoid injuring the superficial veins, which are embedded in the structure of the superficial fascia, and which should now be examined; yet it must not be supposed that any individual description will be in all cases applicable to them, as they are subject to frequent variations in their arrangement.

The Cephalic Vein, the most external, commences on the back of the hand by branches, one from the thumb, another from the index finger, and a third from the external extremity of the dorsal venous plexus; it now winds forwards, over the supinator longus tendon, and about the junction of the inferior and middle thirds of the forearm, sometimes lower, receives a branch formed by radicles from the ball of the thumb, and also another from the median venous plexus, that lies over the annular ligament. As it continues to ascend on the supinator longus, it receives cutaneous branches from the outer and back part of the fore-arm, and at the bend of the elbow, the median cephalic; it now proceeds upwards between the tendon of the biceps, and supinator longus, then between the biceps and triceps, and ultimately between the deltoid and great pectoral, until it arrives at the upper margin of the lesser pectoral, when it turns downwards, backwards, and inwards, and piercing the costo-coraco-clavicular ligament, terminates in the axillary vein.

The Basilic, arises by a large branch from the internal extremity of the dorsal arch, of which it appears to be the more direct efferent vessel; and then ascending along the posterior surface of the ulnar extensor, turns forward at the inferior third of the fore-arm, and joins the vein of the fifth finger (vena Salvatella). The trunk thus formed passes upwards over the flexor ulnaris, receiving at the internal condyle the median basilic; and at the junction of the middle and superior thirds of the arm is joined by the venæ comites of the brachial artery, to constitute the common brachial vein, although it may somctimes terminate in the axillary.

The Median Vein, commences from the median venous plexus over the annular ligament, and ascends in the middle of the fore-arm to about an inch below the flexure of the joint, when it divides into three branches,—median cephalic, median basilic, and mediana profunda.

Median Cephalic, passes upwards and outwards in the depression between the supinator longus and biceps tendon, to join the cephalic, and is the vessel on which phlebotomy should be always performed when practicable.

Median Basilic.—Crosses the semi-lunar fascia of the biceps, the origins of the pronators and flexors, and joins the basilic vein. It generally lies directly over the brachial artery, and for this reason should never be selected for blood-letting, unless under peculiar circumstances.

Mediana Profunda, sinks deep, and, piercing the fascia, communicates with one of the venæ comites of the brachial artery.

When the superficial fascia has been removed, the proper brachial aponeurosis is seen. This latter structure, thick internally, but thin externally, is formed anteriorly and internally, by an expansion from the great pectoral tendon, and a condensation of the areolar tissue of the axilla; and posteriorly and externally, by a continuation of the infra-spinous fascia, and an expansion from the tendons of the teres major, and latissimus dorsi tendons. Completely surrounding the arm, it adheres to the inter-condyloid ridges, and condyles of the humerus, and is intimately connected to the semi-lunar fascia of the biceps in front, and to the tendon of the triceps posteriorly, while a strong layer separates the muscles on the front from the triceps behind, both on the external and internal sides, and these are known as the intermuscular septa.

External Intermuscular Septum, commences above, at the outer lip of the bicipital groove, where it arises from the anterior edge of the tendon of the deltoid, and continues to be attached to the condyloid ridge, as far as the external condyle. It separates the brachialis anticus, the supinator longus, and extensor carpi radialis longior, and brevior, from the triceps behind; and is pierced by the musculo-spiral nerve, and artery, and the external head of the brachialis anticus.

Internal Intermuscular Septum, arises from the inner lip of the bicipital groove, and passing downwards, crosses obliquely the tendon of the coraco-brachialis, which sends fibres to strengthen it, and then descends along the intercondyloid ridge, to be attached to the internal condyle. It separates the brachialis anticus from the triceps, and is pierced by the ulnar nerve, inferior profunda, and anastomotica magna arteries. The brachial aponeurosis also gives sheaths to the biceps, and coraco-brachialis; and where it covers the brachial vessels and nerves internally, is exceedingly strong. Generally speaking, the fibres of this structure are circular in direction, while some exhibit a spiral tendency; but vertical fibres always strengthen the preceding, being more perceptible anteriorly and posteriorly. The several perforations for the cutaneous nerves, are semilunar or arched, but they are never well marked or abrupt, a thin layer being invariably continued from the margin, on the nerve as it escapes through the fascia.

The MUSCLES of the ARM, consist of the triceps posteriorly; and the biceps, coraco-brachialis, and brachialis anticus, in front.

BICEPS FLEXOR CUBITI.—Tendinous above and below, but fleshy in the middle, consists of two heads, long and short; the long head, seen by dividing the capsule, arises from the apex of the glenoid cavity, and passing downwards and outwards over the head of the humerus, leaves the joint between the tuberosities, and enters the bicipital groove, in which it is bound down by an aponeurosis derived from the teres major, and latissimus dorsi behind, and the tendon of the great pectoral in front; this groove is lined by a continuation of the synovial membrane of the joint, but which is again reflected on the fibrous walls, as the tendon leaves the groove; a little above the middle of the arm, the long head becomes fleshy, and meets the short, which had taken its origin from the coracoid process, between the coraco-brachialis and triangular ligament, and had passed downwards and outwards to unite with it. The fleshy belly resulting from the union of the two, runs downwards in the direction of the humerus, and about one inch and a half above the flexure of the elbow, becomes again tendinous, forming in fact a deep tendon, and a superficial aponeurosis. The former, as it continues to descend, has at first one surface directed forwards, the other backwards, but as it sinks deep they become directed inwards and outwards, and, on reaching the radius, it is inserted into the posterior part of the tubercle of that bone, but separated from its anterior by a bursa; the superficial portion, known as the semilunar fascia of the biceps, is crescentic in shape, and arises broad from the outer edge of the tendon; the fibres first pass downwards, then curve upwards and inwards, and are incorporated with the tendinous origins of the pronators, and flexors, and through them, receive a fixed attachment to the internal condyle. We have sometimes seen this muscle inseparably united with the brachialis anticus, but occasionally only a thin slip of fleshy fibres may connect them together.

Relations.—It is covered by the deltoid, great pectoral, capsular ligament, supraspinatus tendon, and brachial aponeurosis. The long head lies on the synovial membrane of the joint, and bone; the short head on a few fibres of the coraco-brachialis, on the external cutaneous nerve, subscapular tendon, and on the anterior circumflex artery; the fleshy belly on the brachialis anticus, and the external cutaneous nerve, the inner edge overlapping the brachial vessels and median nerve; the deep tendon is between the supinator brevis, which it notches at the inner edge, and the brachialis anticus; while the semilunar fascia covers the brachial artery, median nerve, and the origins of the pronators and flexors; and supports the median basilic vein, and internal cutaneous nerve, both of which it separates

from the brachial trunk,—a circumstance which should be recollected in the operation of venesection.

Action.—To raise the humerus, to supinate the hand, and flex the fore-arm on the arm.

Coraco-brachialis, arises fleshy from the point of the coracoid process, and from the short tendon of the biceps; it passes downwards and outwards, and is inserted tendinous into the inner side of the humerus, about the centre of the shaft, afterwards becoming continuous with the internal intermuscular septum.

Relations.—It is covered by the deltoid, great pectoral, and a few fibres of the biceps, with the brachial artery and median nerve on its insertion, and it lies on the subscapular tendon, the axillary artery, brachial plexus, teres major, latissimus dorsi, and long and inner head of the triceps, while it is pierced by the external cutaneous nerve and the nutritious artery of the bone, immediately above its tendon.

Action.—To raise, adduct, and rotate the arm outwards.

Brachialis Anticus.—Situated beneath the biceps, triangular in shape, fleshy above, and tendinous below; arises from the humerus by two fleshy slips, which embrace the insertion of the deltoid, also from the condyloid ridges, the anterior surface of the bone, and the intermuscular septa; the fibres pass downwards and inwards, and terminate in a tendon, which commences on the outer side, broad and thin above, but becoming thicker as it descends, and is inserted into an oblique ridge on the coronoid process of the ulna.

Relations.—The external slip lies between the triceps and deltoid, covered by the external intermuscular septum, and is the longest; and the internal between the coraco-brachialis, and deltoid. It is covered by the biceps, a small portion being superficial externally, by the brachial, and anastomotic arteries and veins, external cutaneous and median nerves, and brachial fascia; and it lies on the bone, the anterior ligament of the elbow-joint, to which it is attached by fleshy fibres, and on the coronoid process; the external edge corresponds to the supinator longus, and the extensor carpi radialis longior, but separated from them by the musculo-spiral nerve, and radial recurrent artery, with anterior branches of the musculo-spiral; and the inner edge to the ulnar nerve, internal intermuscular septum, triceps, and pronator radii teres.

Action.—To flex the fore-arm directly, and strengthen the anterior ligament of the elbow-joint; some of its fleshy fibres being so attached, as to draw the synovial membrane out of the joint, during flexion.

Triceps Extensor Cubiti, is the only muscle on the posterior part of the arm, and consists of three heads, external, middle, and internal; the middle or long head, arises tendinous from the inferior

costa and neck of the scapula, and is prolonged from the last-named point, on the inferior surface of the capsular ligament; it soon becomes fleshy, and descending between the teres major, and minor muscles, on the back of the humerus, but without any direct attachment to it, joins the external head, which arises narrow and tendinous from a ridge below the great tuberosity, and insertion of the teres minor, continuing to be connected as it descends to the outer side of the bone and external condyloid ridge, to the external intermuscular septum and external condyle, the fibres ascending from this last point; while the internal head springs somewhat tendinous, but narrow, from the inner side of the humerus, commencing below the insertion of the teres major, and in its course downwards continues to adhere to the bone, internal condyloid ridge, and the inner condyle; at the junction of the upper and middle thirds of the arm, the three portions become fused together, and about three inches above the olecranon, end in a triangular flat tendon, which first gives off a superficial expansion to become continuous with the fascia of the fore-arm, and then is inserted into the summit of the olecranon process.

Relations.—The long head has in front the teres major, behind the teres minor, and is also overlapped by the deltoid; while it is separated from the humerus, first by the posterior circumflex artery and nerve; then by the musculo-spiral nerve, and superior profunda artery, and lastly by the posterior ligament of the elbow-joint; the posterior edge of the scapular portion is covered by the circumflexus scapulæ artery, as it escapes from the axilla; but in the rest of its extent is superficial. The external head is covered in its upper third by the deltoid posteriorly, but externally it is superficial, while anteriorly and internally it is related to the long head and the bone, external intermuscular septum, the musculo-spiral nerve and artery, which pierce it, and to the extensor carpi radialis longior, and supinator longus. The internal head corresponds externally to the bone and long head, to the brachial, and inferior profunda arteries, to the ulnar nerve, the coraco-brachialis, intermuscular septum, and brachialis anticus; a bursa separates the fascia from the superficial expansion of the triceps, at its insertion; and a second is interposed between the tendon and the olecranon.

Action.—To extend the fore-arm, and draw the arm backwards; while it also strengthens the capsular ligament of the shoulder-joint inferiorly. The sudden action of this muscle may fracture the olecranon, but the ascending fibres, together with the superficial expansion, tend to prevent the great amount of separation of the fragments that might be anticipated. Between the long head and the subscapularis, the capsular ligament is uncovered to a large

extent; and it is here the humerus escapes in axillary dislocation; but we have frequently observed this space remarkably strengthened by a band uniting the teres major, subscapular, and long head of the triceps.

DISSECTION OF THE FORE-ARM.

The integument on the front of the fore-arm is fine, thin, and loosely adherent to the subjacent fascia, but gradually diminishes in thickness towards the annular ligament, as is evidenced by the facility of observing the plexiform arrangement of the veins in this position, but on passing to the palm of the hand, while it still continues thin, it becomes more dense, and firmly adherent to the fascia beneath, except laterally on the thenar eminence (ball of the thumb) and hypo-thenar eminence (ball of little finger), where it is much finer and more movable. Three transverse depressions are also seen in the palmar integument; one generally commencing at the interthenar space, and taking a direction downwards, forwards, and outwards; a second passing inwards, and upwards, from the external termination of the last; and a third proceeding from the anterior third of the hypo-thenar eminence outwards, and generally ending at the base of the middle finger. Of these, the first corresponds to the axis of flexion of the metacarpo-carpal articulation of the thumb; and the second, and third, to the axis of flexion of the four fingers as opponents of the thumb. If we now follow the skin on the palmar aspect of the fingers, it is found to be dense on the phalanges, but sulcated and fine, opposite the angle of flexion of each joint; while at the extremities of the finger it is fine and highly organized, but the density is here subject to great variety, influenced in all cases by its being liable to friction or otherwise. On the back of the fore-arm the skin is somewhat stronger than it is in front, but is extremely fine and movable on the back of the hand and fingers, and terminates in a lunated fold, at the root of the nail. Ordinary sensibility prevails in this situation, and tactile on the palmar aspect.

An incision may now be made along either border of the forearm, and prolonged on the thenar, and hypo-thenar eminences of the hand; and the skin, slit up each finger to its extremity; the flap being thrown down both on the back and front, of the fore-arm and hand, exposes the superficial fascia, which does not offer any peculiarities, but contains in its tissue several plexiform meshes of veins, and some cutaneous nerves. The latter or those in front, are the internal cutaneous; external cutaneous; cutaneous branch of the ulnar, to communicate with the internal cutaneous; short radial cutaneous from the radial nerve, an inch above the wrist; palmar and thenar cutaneous from the median, two inches above the annular ligament;

and on the posterior part, the spiral cutaneous; posterior branch of external cutaneous; radial nerve; and dorsal branch of the ulnar.

The fascia, or investing tunic, continuous before and above with the semilunar fascia of the biceps, and behind with the superficial expansion of the triceps, is attached to each condyle, to the posterior edge of the ulna in its whole length, and below to the annular ligaments both anterior, and posterior. This fascia, consists of two sets of fibres; the superficial, observing a longitudinal direction; and the deep, a transverse or oblique; it is stronger behind than before, and increases gradually in density, as it descends towards the wrist; superiorly, it gives attachment, by its deep surface, to the fleshy fibres of the several muscles, and sends off aponeurotic septa, which insulate and separate them from each other; forming in fact trumpet-shaped sheaths, which are wide above, and narrow below. A thin layer also passes between the superficial muscles on the front of the fore-arm and the flexor sublimis, while a second likewise separates the latter from the third or deepest set of flexors—the superficial and deep layers of extensors, being isolated in a similar manner by a thin process, and the several muscles both anteriorly and posteriorly being surrounded each by a distinct sheath or tubule, that follows its course and figure. The radial, and ulnar arteries, with their accompanying nerves, also possess distinct sheaths; but they are only well-marked on the ulnar side, in the inferior third of the fore-arm.

Anterior Annular Ligament.—A strong aponeurotic band or arch, stretching across the carpus; attached internally, to the pisiform, and to the hamulus of the unciform bone; and externally, to the trapezium, and scaphoid. It is deeper and more defined on the external side, but stronger on the internal, from receiving a slip sent off from the tendon of the flexor carpi ulnaris, to bind down the ulnar nerve, and artery:—the tendon of this muscle appearing to split the ligament in this situation, while that of the radial flexor seems to do so, also externally; but with the latter, this arrangement is only exceptional. To the upper edge of the ligament, the fascia of the fore-arm is intimately attached; and to its lower, the palmar aponeurosis as closely adheres. The anterior surface is crossed by the flexor ulnaris, and palmaris longus tendons; by the ulnar, and median cutaneous nerves, and by the superficialis volæ, and ulnar arteries: while the deep, completes an osteo-fibrous canal of communication, between the fore-arm and palmar region, which is bounded behind by the concave anterior aspect of the carpus; it therefore necessarily follows, that the space is semilunar in figure, straight in front, and hollowed out behind, giving transmission to the tendons of the flexor sublimis, profundus, pollicis, and radialis muscles, with the branches of the median, and anterior interosseous arteries:—the

median nerve, lying between the superficial, and deep flexors. The use of this fibrous arch is, to retain the tendons in their position, during the contraction of the muscles, and in order to facilitate their movements, a large bursa, which will be described hereafter, surrounds them.

In the fatty areolar tissue, which covers the palmar fascia anteriorly, a small cutaneous muscle is situated, but not, however, invariably present.

Palmaris Brevis.—Thin and indistinct; arises from the annular ligament, internal to the middle portion of the palmar fascia, and passing forwards and inwards, is inserted into the deep surface of the skin, covering the muscles of the little finger, and occasionally continued for some distance posteriorly. It is subcutaneous, and rests on the palmar fascia, which separates it from the ulnar artery, and nerve. We have traced a branch of the median cutaneous nerve into its structure.

Palmar Fascia.—Triangular in shape, with the apex behind, attached to the annular ligament, and tendon of the palmaris longus muscle, and the base anteriorly broad and expanded, and divided into four slips, which at the point of division are bound together by a dense silvery band passing from one to the other. Each slip at the base of the first phalanx of the corresponding finger, forms an arch over the flexor tendons, the edge being attached to the digital sheaths; and the extremities prolonged and sinking deeply to be inserted into the side of the base of the first phalanx, and lateral ligaments; while a second process, given off by each, becomes continuous with a similar one from the next finger, thus producing a triangular space between the fingers for the passage of the digital vessels, and nerves, with the tendons of the lumbricales, and interossei. The internal, and external margins, of the palmar fascia sink deep, and are attached to the metacarpal bones of the index, and fifth fingers, thus separating the muscles of the thumb and little finger, from those in the middle of the palmar region. This structure is principally composed of longitudinal fibres, except anteriorly, where, as we have already stated, they are transverse superficially, to preserve the integrity of the subdivisions. It may be necessary to remark, that in addition to the mesial process just described, a thin layer of fascia also covers the thenar, and hypo-thenar muscles, continuous on either side with the mesial portion, attached above to the annular ligament, and forming below sheaths for the muscles of these eminences.

These fasciæ adhere closely to the skin which covers them, but are separated from the subjacent parts, in the middle region, by a variable quantity of fat. The middle portion, by its resistance, pro-

tects the subjacent nerves, and vessels from undue pressure, particularly when made tense by the palmaris longus, while by its density it may also act injuriously, in restraining deep-seated matter from reaching the surface in this direction, as in paronychia palmaris.

Digital Sheaths, are dense planes of fibrous tissue, extending from the base of the first, to that of the last or ungual phalanx, and attached laterally to the margins of the bones, thus constituting an osteo-fibrous canal, two-thirds of which is fibrous, and one-third osseous, the latter being formed by the anterior or concave surface of the phalanges. Opposite the flexures the sheath is weak, and occasionally deficient, so that the synovial membrane may protrude during flexion, while posteriorly it is attached to the palmar fascia, and anteriorly lost on the insertion of the flexor profundus. The fibres composing it, are transverse and remarkably strong, and it contains the superficial, and deep flexor tendons, the motions of which are facilitated by a bursal membrane, with which it is provided. Subfascial inflammation in this situation, constitutes one of the most dangerous forms of paronychia, as the matter cannot reach the surface in consequence of the dense covering, and it consequently becomes diffused into the palmar region, and may ultimately travel up the forearm.

Posterior Annular Ligament.—Much weaker than the anterior, and in depth about half to three-quarters of an inch, arises from the styloid process of the radius, passes downwards and inwards, and is inserted into the pisiform bone, and the fascia covering the styloid process of the ulna; in its passage across, it likewise adheres to the bony ridges which separate the grooves on the back of the radius; above, it is continuous with the fascia of the fore-arm, of which it is a part, merely strengthened by transverse fibres; and below, with the fascia of the dorsum of the hand, which is weak, being prolonged over the back of the hand and fingers, and connected to the subjacent tendons, by a fine but lax areolar tissue, that permits those tendons to glide with facility on the adjacent surfaces.

The Muscles to be examined in this region, consist of those of the fore-arm, and hand; the former consisting of the pronators, and flexors on the front; and the supinators, and extensors on the posterior part of the fore-arm. As the origins of these several muscles are complex and difficult, it may here be remarked, that the majority of the pronators, and flexors are attached to the internal condyle; and the supinators, and extensors to the external condyle, of the humerus.

When the integument has been raised, the removal of the fascia may be much facilitated, at least for some distance, by dissecting it up from below; but superiorly, it adheres so intimately to the fleshy fibres

beneath, that some difficulty will be experienced, and much care required in the dissection, particularly in separating the several muscles from each other; and this also should be done from below upwards, as it is much easier to separate the tendons, than their fleshy bellies.

The muscles on the front of fore-arm, are placed in three layers from superficial to deep;—the first consisting of four, viz.,—pronator radii teres, flexor carpi radialis, palmaris longus, and flexor carpi ulnaris; the second of only one,—the flexor digitorum sublimis; and the third of three, viz.,—flexor pollicis longus, flexor digitorum profundus, and pronator quadratus.

Pronator Radii Teres, or Rotundus.—Round above, flat below, and placed obliquely in the upper third of the fore-arm, arises tendinous and fleshy from the lip of the humerus above the inner condyle, as well as from the latter point of bone, from the fascia, and a strong aponeurotic septum, which separates it from the radial flexor; also by a fleshy and tendinous slip from the coronoid process of the ulna, internal to the brachialis anticus—the median nerve passing between those osseous attachments; the fibres pass downwards and outwards, and form a flat tendon by which it is inserted into the outer and back part of the radius, a little above its centre; the tendon first appears on the anterior surface, and is about an inch in length, while sometimes the superior half of the insertion is tendinous, and the remainder fleshy.

Relations.—It lies on the brachialis anticus, the anterior ulnar recurrent, and ulnar arteries, on the flexor digitorum sublimis, median nerve, and ulnar slip of flexor pollicis longus; and is covered by the semilunar and general investing fascia, by the radial artery, and nerve, and the supinator longus, with the extensor carpi radialis longior, and brevior muscles; the inner margin corresponds to the flexor carpi radialis, and the outer to a triangular space (ante-cubital fossa), where it overlaps the biceps tendon, brachial artery, and median nerve; its ulnar attachment always separates the median nerve from the ulnar artery.

Actions.—First to pronate, and then flex the fore-arm; while from the favourable angle of its insertion, its power is equal to the combined action of all the supinators.

Flexor Carpi Radialis, internal to the last, arises tendinous from the internal condyle, fascia, and intermuscular septa, and soon becoming fleshy, passes downwards and outwards, until arriving at the junction of the upper and middle thirds of the fore-arm it terminates in a tendon, which descends beneath, frequently through the annular ligament, and crossing obliquely the tendon of the flexor pollicis longus, enters a groove in the os trapezium, which is sometimes common to it and the scaphoid, in which it is bound down by a fibrous

layer, the groove being lined by a distinct bursal membrane; it then expands and is inserted into the anterior part of the head of the metacarpal bone of the index finger, sometimes into that of the third, and more rarely into a projecting point on the trapezium.

Relations.—It is covered by the skin, fascia, and annular ligament of the carpus, and lies on the flexor sublimis, the flexor pollicis tendon and carpus; above, it is between the pronator radii teres and the palmaris longus; but below, between the palmaris longus, and the supinator, but with the radial artery lying between them.

Action.—To flex the carpus, and the fore-arm; and probably to assist in pronating the hand.

PALMARIS LONGUS.—Long and slender, arises tendinous from the inner condyle, and intermuscular septa; and passing downwards and outwards, forms a round, fleshy belly, which at the middle of the fore-arm terminates in a tendon, which at first round, but afterwards flat, passes over the annular ligament, into which, and the middle division of the palmar fascia, it is inserted.

Relations.—It is covered by integuments and fascia, and lies on the flexor sublimis, and annular ligament, having on its outer side the radial flexor, and on its inner the ulnar: it is sometimes wanting altogether, or may be present, on one side only.

Actions.—To make tense the palmar fascia, flex the fore-arm, and assist in pronation. It is large, strong, and powerful in the monkey tribe, for obvious reasons.

FLEXOR CARPI ULNARIS.—The most internal of the superficial layer of muscles; it arises from the posterior part of the internal condyle, and from the inner side of the olecranon, a fascia with transverse fibres uniting the two origins, and concealing the ulnar nerve, and posterior ulnar recurrent artery, that passes between them; it also arises, through the intervention of the fascia of the fore-arm, from the superior two-thirds of the posterior edge of the ulna; from those several origins, the fibres pass downwards and forwards, and form a tendon on their anterior surface, that only ceases to receive fleshy fibres at the carpus; it now crosses over the annular ligament, and is inserted into the pisiform bone, and by a vertical slip into the head of the fifth metacarpal bone.

Relations.—It is only covered by the fascia, and lies on the ulnar nerve, artery, flexor sublimis, ulna, pronator quadratus, and annular ligament, from which a bursa separates it; while from the outer edge of the tendon, a process passes to the annular ligament, to bind down the ulnar nerve, and artery; but many consider this process to be nothing more than a superficial stratum of the ligament itself, which they regard as being split by the tendon. The bursa of the tendon passes beneath the nerve, and artery, sometimes wholly surrounding

the latter; and in the two inferior thirds of the fore-arm, the tendon serves as a guide to the artery, but it should be borne in mind that the nerve is always in the closest proximity with it.

Action.—To flex the wrist, and fore-arm on the arm; also to adduct, when aided by the extensor ulnaris. The power of this muscle is greatly increased, by the intervention of the pisiform bone, which augments the angle of its insertion; and this power is also still further intensified, according to the degree of flexion existing in the fore-arm.

Flexor Digitorum Sublimis, or Perforatus, is seen by dividing the superficial muscles that have been already described, and constitutes by itself, the second layer. It arises tendinous from the inner condyle, and anterior part of the coronoid process; and tendinous and fleshy from the radius, between the insertion of the supinator brevis, and flexor pollicis, also from the fascia, and intermuscular septa; it forms a fleshy belly, that after a short course, shows a tendency to a subdivision into four slips, and to these succeed four tendons arranged in pairs, in the following manner—two anterior, for the middle and ring fingers; and two posterior, smaller and often with a fleshy interruption, for the index, and little finger; they all pass beneath the annular ligament in company with the deep flexor, median nerve, and the flexor of the thumb, involved in a common bursa; and diverging from each other, in the palm of the hand, reach the base of the first phalanx, where they enter the digital sheath, with the deep flexor; at the middle point of the first phalanx each tendon divides, to allow the deep to pass through them, and then again uniting posterior to them, form a concavity behind for their reception, but each separates a second time before they are ultimately inserted into the margins of the second phalanx.

Relations.—It lies on the flexor profundus, ulnar artery, median nerve, which is to its outer edge; on the flexor pollicis, bursa, and phalanges; and it is covered by the superficial layer of muscles, a strong fascia, annular ligament, the digital sheath, and tendons of the deep flexor at the point of insertion. The bursal apparatus in connexion with these tendons requires, from its importance, a distinct description; it commences half-an-inch above the annular ligament, and extends for fully one inch into the palm of the hand, the anterior surface, being connected to the annular ligament, and the posterior to the carpal bones; while it envelopes the superficial, and deep flexors, the median nerve, and flexor pollicis. In raising the superficial flexor we have frequently seen trabeculæ, passing apparently through the sac of the bursa, uniting it with the deep flexor. The sac is large and expanded, while in connection with the muscles of the fingers, but contracted and shallow, where it encloses the flexor of the thumb. In bursal inflammation in this situation, the anatomical arrangement ex-

plains the peculiarity of configuration; the swelling being well marked above the wrist, less so in the hand, whilst a depression corresponding to the unyielding annular ligament, divides the tumour into two unequal portions. The division of the annular ligament, to reach the bursa when diseased, has been recommended (Syme).

The muscles in the third layer, are exposed by dividing the flexor sublimis, but in doing so, care must be taken to avoid the median nerve, which is closely united to its posterior surface; the three to be now examined are the following,—flexor digitorum profundus, flexor pollicis longus, and pronator quadratus.

Flexor Digitorum Profundus, or Perforans, arises fleshy from the inner side of the coronoid process, from the three superior fourths of the anterior surface, and inner edge of the ulna, and by a few fibres from the radius below its tubercle, also from the inner two-thirds of the interosseous membrane; passing downwards, it forms four fleshy slips; and to these succeed a corresponding number of tendons, which lie in contact with each other, the three inner being united by areolar tissue, or sometimes tendinous bands, while that for the index finger is always distinct and free; they pass beneath the annular ligament, enveloped in the carpal bursa, and expand in the palm of the hand, where they give attachment to the lumbricales; they now enter the digital sheaths, and piercing the superficial flexors, terminate by being inserted into the ungual phalanges.

Relations.—It is covered by the flexor sublimis, the median nerve, and median branch of the ulnar artery, by the ulnar artery itself, which lies between it and the flexor sublimis above, and between it and the flexor ulnaris below; also by the annular ligament, the superficial arch of arteries, and nerves, and the digital sheaths; and it lies on the radius, ulna, and pronator quadratus, interosseous ligament, and vessels, carpus, interossei, phalanges, and insertion of the flexor sublimis tendons; while the outer edge, corresponds to the flexor pollicis; and the inner, to the flexor ulnaris.

Action.—To flex the last phalanx, and the wrist; the tendons are firmly bound down, by the splitting and insertion of the superficial flexor; while the slip that passes to the index finger can act separately, as it is not closely connected with the others.

Flexor Pollicis Longus.—Narrow and fleshy above, but tendinous below; arises from the anterior and inner edge of the radius, from the tubercle above, to the pronator quadratus below; also from the outer third of the interosseous ligament, and from the coronoid process, of the ulna by a fleshy slip, which always is adherent to the flexor sublimis on its deep surface, and which is sometimes digastric; the fibres all terminate in a tendon formed on the anterior surface, with a semi-penniform arrangement, which pass-

ing beneath the annular ligament, and lying most external in this situation, crosses obliquely the os trapezium, next runs between the two heads of the short flexor, where it is surrounded by a bursa, then between the sesamoid bones at the base of the first phalanx of the thumb, when it is received into the digital sheath, and ultimately inserted into the ungual phalanx.

Relations.—This muscle is covered by the radial origin of the flexor sublimis, radial artery, and nerve, supinator longus, radial flexor tendon, annular ligament, outer head of flexor pollicis brevis, and digital sheaths, and lies on the flexor profundus by its coronoid origin, on the radius, interosseous ligament and vessels, carpus, pronator quadratus, inner head of flexor pollicis brevis, and phalanges; the outer edge lies in contact with the supinator longus, while internally, it is in close proximity with the flexor profundus, from which, however, it is separated by the anterior interosseous artery, and nerve.

Action.—To flex the wrist-joint, also the thumb; the latter action being increased by its curving around the trapezium bone.

The two last muscles may now be divided, which brings into view the following:—

Pronator Quadratus.—Square in shape, as its name implies; arises from the inner edge, anterior surface, and external margin of the inferior fifth of the ulna; the fibres pass outwards and downwards, and are inserted into the anterior surface, and outer edge of the inferior fourth of the radius.

Relations.—It is covered by the superficial, and deep flexor; ulnar, and radial flexors, and radial artery; and lies on the interosseous ligament, and bones. The fibres of this muscle are of different lengths, the superficial, being attached to the distal edges of the bones, and the deep, which are much shorter, to the proximal; a branch of the interosseous artery, and nerve, enter the muscle at the upper edge, for its supply.

Action.—To pronate the hand, and preserve the bones in contact; while in that fracture of the radius described by Mr. Colles, it draws the fragments towards the ulna, and thus oblitcrates the interosseous space.

The muscles on the outer side and back of the fore-arm, are twelve in number, and are divided into a superficial and deep layer; the muscles constituting the former are seven in number, viz., supinator radii longus, extensor carpi radialis longior, and brevior, extensor digitorum communis, extensor minimi digiti, extensor ulnaris, and anconeus; while in the latter there are five, viz., the supinator radii brevis, extensor ossis metacarpi pollicis, extensor primi internodii pollicis, extensor secundi internodii pollicis, and the extensor indicis.

Supinator Radii Longus is the most external of the superficial layer, and forms the fleshy mass on the outer side of the fore-arm; it arises narrow and fleshy, below the insertion of the deltoid, from the external condyloid ridge, and continues adherent to the bone to within one inch and a half of the external condyle, also from the intermuscular septum, which separates it from the triceps; it forms a fleshy belly, which descends on the outer side of the elbow-joint, and about the middle of the fore-arm becoming tendinous, is inserted into the rough crest, or sometimes into a depression above the styloid process of the radius.

Relations.—It is covered by the aponeurosis of the arm and fore-arm; and corresponds internally, in the arm, to the brachialis anticus, and biceps tendon, from which it is separated from superficial to deep, by the cephalic vein, external cutaneous, and musculo-spiral nerves, radial recurrent, with anterior branches of the musculo-spiral artery; lower down, it lies on the extensor carpi radialis longior, and brevior, flexor pollicis, pronator teres, and radial artery, and the dorsal branch of the radial nerve, while its insertion is between the flexor pollicis, and the extensor ossis metacarpi. In the arm, it has behind it, the external intermuscular septum with posterior branches of the musculo-spiral artery, and triceps; and its origin above, is separated from the deltoid by the musculo-spiral nerve, and one head of the brachialis anticus. Frequently in the arm, its belly is extremely thin, being flattened by its pressure against the brachialis anticus, but in the fore-arm, where this pressure is removed and it is left free to expand, it is then flattened from before backwards; the inner edge of the belly, serves as a guide to cutting down on the brachial artery, at the bend of the elbow; and it, as well as the tendon, acts in a similar way to the radial artery in the fore-arm.

Action.—To supinate the hand, when it has been pronated, and afterwards to flex the fore-arm, its power being greatly augmented by the length of the acting arm of the lever, to which it is attached. When this muscle is cut across and reflected, the following is exposed—

Extensor Carpi Radialis Longior.—Arises from a rough triangular space, into which the external condyloid ridge expands below, about one inch and a half in length, also from a tendon common to it, and the short extensor, and from the external intermuscular septum; it then forms a fleshy belly, that terminates in a tendon above the middle of the fore-arm; which descends to the inferior third of the radius, where it turns slightly backwards, and passing beneath the posterior annular ligament, in a groove behind the styloid process, is inserted, flat, into the head of the metacarpal bone of the index finger.

Relations.—It lies on the humerus, on the extensor carpi radialis

brevior, and wrist-joint; and is covered by the supinator longus, the extensor ossis metacarpi, and primi internodii and secundi internodii pollicis with the radial artery.

Action.—It extends the fore-arm on the arm, and the wrist on the fore-arm; it also abducts the wrist.

Extensor Carpi Radialis Brevior, immediately beneath the last, arises tendinous from the external condyle, and from a tendon common to it, and to the last-described muscle; it forms a fleshy mass, projecting on each side of the long extensor, and at the junction of the upper and middle thirds of the fore-arm, terminates in a long flat tendon, which descends, first along the outer side, and then on the posterior part of the radius; it now passes through a groove common to it, and to the long extensor, provided with a bursal membrane, in which it is bound down by the posterior annular ligament; and becoming more expanded, is inserted into the head of the metacarpal bone of the middle finger.

Relations.—It is covered by the extensor carpi radialis longior, and the tendons of the extensors of the thumb; and lies on the supinator brevis, on the pronator teres, radius, carpus, and metacarpal bone. The fleshy belly of this muscle is always thicker and longer and its tendon shorter and broader than that of the extensor carpi radialis longior.

Action.—To extend the carpus and abduct the hand; also to supinate slightly.

Extensor Digitorum Communis, internal to the last, arises by a triangular tendon, common to it and the former muscle, from the external condyle, from the fascia which covers it, and the intermuscular septa; it forms a thick fleshy belly, but somewhat flattened, ending a little below the middle of the fore-arm, in four slips, which terminate in a corresponding number of tendons, those for the middle and ring fingers being the larger; the compound tendon then passes through a groove on the back of the radius, provided with a bursa, which projects above and below the annular ligament, and, on reaching the back of the hand, separates for the four inner fingers, presenting the following peculiarities; at the head of the metacarpal bone they are round, and communicate—that for the little finger with that for the ring, and that of the ring with that of the middle: while the index tendon remains perfectly distinct; on the first phalanx, they are wide, and receive the insertion of the lumbricales; but at the second, they divide into three slips, the central one of which is inserted into the anterior extremity of the second phalanx; while the lateral, run along its sides, and unite on the last, into which they are ultimately inserted.

Relations.—It is covered by the fascia, and posterior annular liga-

ment, and rests on the supinator brevis, the posterior interosseous artery and nerve, the extensors of the thumb and index finger, also on the radius, wrist, metacarpus, and phalanges, while it lies between the short radial extensor and extensor minimi digiti.

Action.—To extend the phalanges, the wrist-joint, and fore-arm; in consequence, however, of the slip to the index finger being free, it can act separately; but many persons can also extend either of the other fingers independently, an art that may be acquired by habit.

Extensor Minimi Digiti, or Auricularis.—Internal to the last; arises narrow and tendinous from the external condyle, and from the fibrous septa, which separate it from the common and ulnar extensors, it forms a narrow fleshy belly, compressed laterally, succeeded by a small flat tendon below the middle of the fore-arm, which passes on the back of the articulation between the radius and ulna, and under the posterior annular ligament, where it is provided with a bursa; continuing its course over the fifth metacarpal bone, on which it is retained by a fibrous sheath and synovial membrane, it receives at the head of the metacarpal bone, a slip from the common extensor, and is inserted into the posterior aspect of the phalanges of the little finger, becoming continuous with the tendon of the latter muscle.

Relations.—It lies on the extensors of the thumb, and index finger; on the ulna, carpus, metacarpal bone, and phalanges; and is covered by the fascia and annular ligament, having the common extensor to its outside, and the ulnar, to its inside.

Use.—To extend the fifth finger, and the carpus; while it may also slightly adduct the hand.

Extensor Carpi Ulnaris, arises by a triangular tendon, from the posterior part of the external condyle, from the posterior surface and middle third of the posterior ridge of the ulna, and from the fascia which covers it; the tendon commences in the fleshy structure of the muscle, and at the inferior third appears on the posterior surface, constituting a semipenniform muscle; it runs beneath the posterior annular ligament in an oblique groove, external and posterior to the styloid process of the ulna, provided with a bursa; then passes behind the wrist-joint, and increasing somewhat in width, is inserted into the head of the metacarpal bone of the fifth finger.

Relations.—It is covered by the fascia, and annular ligament; and lies on the extensors of the thumb, and index finger; on the ulna, carpus, and metacarpal bone; above, it is between the anconæus, and the extensor minimi digiti; and below, between the latter, and the flexor ulnaris.

Action.—To extend the ulnar side of the carpus, and the fore-arm; also, to assist the flexor ulnaris in adducting the hand.

Anconæus.—Triangular in shape, arises by a distinct flat tendon from the back part of the external condyle; the fibres pass inwards, the superior transversely, the inferior obliquely downwards and inwards, to be inserted, by short tendinous fibres, into the outer side of the olecranon process, which is here rough and triangular, and into the ulna for about two inches.

Relations.—It is covered by the superficial expansion of the triceps, and a bursa ; and lies on the ulna, coronary ligament of the radius, and posterior interosseous recurrent artery, which separates it from the supinator brevis ; the upper margin corresponds to the triceps, a cellular interval intervening between them ; the outer edge corresponds to the flexor ulnaris.

Action.—To extend the elbow, and to draw the synovial membrane out of the joint during extension ; but it has no power whatever to rotate the arm inwards, as has been sometimes stated. This muscle is analogous to the poplitæus in the lower extremity.

DEEP LAYER.

Supinator Radii Brevis.—Flat, and embracing the upper part of the radius ; but to examine its attachments properly, the hand should be forcibly pronated. It arises from the external condyle, external lateral ligament, with which its tendon is inseparably united, from the coronary ligament of the radius, from a ridge below the lesser sigmoid cavity of the ulna, and a triangular concave surface behind that ridge ; the fibres pass obliquely downwards, outwards, and forwards, and are inserted into the external and anterior part of the radius, above and below the tubercle.

Relations.—It lies on the radius ; on the coronary, external lateral, and interosseous ligaments ; and is covered externally, by the supinator longus, extensor carpi radialis longior, and brevior, and the posterior interosseous nerve, which pierces its external fibres ; posteriorly, by the anconæus, extensor ulnaris, extensor minimi digiti, and communis, and by the posterior interosseous recurrent artery ; and anteriorly, by the inner edge of the supinator longus, radial artery, nerve, and pronator radii teres. The biceps tendon notches its inner edge, and sometimes the superior portion is altogether tendinous, the fleshy fibres being only seen on the anterior part.

Action.—To extend the fore-arm, or roll the radius outwards : and when it is fleshy above, to make tense the coronary ligament of the radius, and strengthen generally the articulation.

Extensor Ossis Metacarpi Pollicis.—Arises from the posterior and inner part of the ulna, below the anconæus, from the posterior surface of the radius below the supinator brevis, and from the in-

terosseous ligament; the tendinous origin ending immediately in a fleshy belly, which is flat on the deep surface; it passes obliquely downwards and outwards, terminating in a tendon, which runs at first downwards and outwards, and then vertically downwards on the outer edge of the radius, when it is received into a groove in front of the styloid process, where it is bound down by a strong fibrous sheath lined by a bursa; it next crosses the anterior edge of the external lateral ligament, and divides into two slips, the broader of which is inserted into the head of the metacarpal bone of the thumb, and the narrower into the trapezium bone.

Relations.—It is covered above by the superficial layer of muscles; but below, lies merely under the fascia; it rests on the ulna, interosseous membrane, radius, radial extensors, radial artery, and external lateral ligament of the wrist-joint.

Extensor Primi Internodii Pollicis, or, the Extensor of the First Joint of the Thumb, internal to the last muscle, to which it is intimately connected, arises tendinous from the ulna, and interosseous ligament, receiving a few fibres from the radius, below the extensor ossis metacarpi; it then becomes fleshy, and, passing obliquely downwards, forwards, and outwards, ends in a tendon that pursues a similar course; is received into the same groove with the extensor ossis metacarpi, but separated from it by a septum; and, crossing over the back of the metacarpal bone, is inserted into the base of the first phalanx of the thumb.

Relations.—These are the same as those of the last muscle.

Action.—Both this and the preceding muscle, abduct the thumb and wrist-joint, which they also extend, while the extensor primi internodii, in addition, extends the first phalanx of the thumb. Both, are also supinators of the hand.

Extensor Secundi Internodii Pollicis.—Narrower and shorter than the last; arises from the outer surface of the ulna, internal and inferior to the extensor primi, from the interosseous membrane, and from the strong septum separating it from the extensor indicis; it ends in a fleshy belly, to which succeeds a tendon, very low down, that enters a distinct groove in the radius, bound down by the posterior annular ligament, and lubricated by a bursa; it next crosses the radial extensors, the first interosseous space, then the metacarpal bone of the thumb, and first phalanx, and terminates by being inserted into the last, or ungual phalanx.

Relations.—Similar to those of the former; but it is much longer, as the insertion is advanced to the last joint.

Action.—Similar to that of the extensor primi; but, in addition, it extends the last phalanx of the thumb.

Extensor Indicis.—Internal to the last; arises from the outer

and back part of the ulna, the interosseous ligament, and intermuscular septum, and forms a fleshy belly, terminating in a tendon at the annular ligament; it now enters the groove for the extensor communis, lying between that tendon, and the extensor secundi internodii pollicis, and passing over the carpus and second interosseous space, at the anterior extremity of the metacarpal bone, it joins the outer tendon of the extensor communis, with which it is inserted into the second, and third phalanges.

Relations.—It is covered by the superficial layer, and interosseous vessels, and nerves; and lies on the ulna, interosseous membrane, radius, carpus, first dorsal interosseous muscle, near its back part, and lastly, on the phalanges.

Action.—To extend the wrist, and independently, the index finger.

The muscles of the palm of the hand, are divided into those of the thumb (thenar), of the little finger (hypothenar), and of the middle (palmar proper). The muscles of the thumb, are five in number,—abductor pollicis, opponens pollicis or flexor ossis metacarpi, flexor pollicis brevis, adductor pollicis, and the abductor indicis.

Abductor Pollicis, arises tendinous and aponeurotic, from the annular ligament, the scaphoid bone, and from that portion of the trapezium which receives the insertion of the extensor ossis metacarpi; it passes forwards, outwards, and downwards, forming a flat tendon, which is inserted into the outer and back part of the first phalanx of the thumb.

Relations.—It is covered by the outer portion of the palmar fascia, and lies on the opponens, but is separated from it by a thin fascia; the arteria superficialis volæ sometimes perforates its origin, or it may run between it and the opponens.

Action.—To draw the thumb forwards, and inwards; it would be therefore more correct to call it an adductor.

Opponens Pollicis, or Flexor Ossis Metacarpi.—Triangular in shape, thick, and fleshy, arises from the trapezium, but sometimes from the scaphoid bone, and annular ligament; the superior fibres pass directly downwards, and the others downwards and outwards, and are inserted into the inner edge of the whole length of the metacarpal bone of the thumb, extending as far as the base of the first phalanx.

Relations.—It lies beneath the abductor, and fascia; and rests on the first carpo-metacarpal articulation, and the metacarpal bone; while the inner edge corresponds to the flexor pollicis brevis.

Action.—To flex the metacarpal bone, and thus antagonize the extensor ossis metacarpi.

Flexor Pollicis Brevis.—To see the inner head of this muscle, the outer tendon of the long flexors must be removed, and drawn

inwards, with the lumbricales, when it will be seen to consist of two heads—an external, and an internal; the former arising from the scaphoid, trapezium, and annular ligament; and the latter, which is deeper, from the sheath of the radial flexor, os magnum, and head of the metacarpal bone of the middle finger. The two heads proceed towards the base of the first phalanx, and becoming tendinous, are inserted into the sesamoid bones, and, crossing these obliquely, into the base of the first phalanx.

Relations.—The outer head is covered above by the adductor, but below is superficial; and the inner, by the flexor tendon, and bursa, the long flexor tendon lying between the two portions; the outer head rests on the abductor indicis, and radial artery; and the inner on the first palmar interosseous, metacarpal bone, and on the radialis indicis, princeps pollicis, and palmaris profunda arteries.

Action.—To flex the first phalanx, and metacarpal bones.

Adductor Pollicis, lies below the inner head of the short flexor, but on the same plane, and is triangular in shape. The base which constitutes its origin arises from the superior three-fourths, or sometimes less, of the anterior surface of the middle metacarpal bone, and passing outwards, converging, is inserted tendinous into the inner sesamoid bone, and the base of the first phalanx.

Relations.—It is covered by the two outer tendons of the flexor sublimis, and profundus, lumbricales, branches of the median nerve, and a thin fascia; and lies on the metacarpal bones of the middle and index fingers, and corresponding interosseous muscle, on the abductor indicis, and terminal branches of the radial artery; the upper edge corresponds to the inner head of the short flexor, with which it is sometimes united; while the lower is round and fleshy, and projects beyond the abductor indicis, on the external side of the cleft between the thumb and index finger. The palmaris profunda artery passes between its upper edge, and the flexor pollicis. This muscle is considered by some anatomists, as the first palmar interosseous.

Action.—To adduct the thumb.

Abductor Indicis.—Triangular in figure, like the last-described muscle, and seen on the back of the cleft between the thumb and index finger, arises tendinous and fleshy from the posterior third of the metacarpal bone of the thumb, and from the entire of the outer edge of that of the index finger; the fibres pass upwards from the latter, and upwards and outwards from the former, and are inserted tendinous, into the outer side of the base of the first phalanx of the second finger.

Relations.—It has anterior to it, the adductor, and flexor pollicis brevis muscles, and the termination of the radial artery; and poste-

rior to it, the integuments, and extensor secundi internodii pollicis; its two origins are separated by the radial artery, and its veins.

Action.—To abduct the index finger, and adduct the thumb; this muscle may be also considered to be the first dorsal interosseous.

The muscles of the hypo-thenar region are three in number, namely, the abductor, flexor brevis, and adductor minimi digiti.

Abductor Minimi Digiti, arises tendinous from the pisiform bone, annular ligament, and the insertion of the ulnar flexor tendon; it passes downwards, and is inserted by a short tendon into the inner side of the base of the first phalanx.

Relations.—It is superficial, and lies on the flexor brevis, a portion of which is seen at its outer edge.

Action.—As its name implies; but as it moves the little finger towards the middle line of the body, it would be more properly named an adductor.

Flexor Minimi Digiti Brevis.—Sometimes wanting; but when present, lying to the outer edge of the last; arises tendinous from the unciform bone, and annular ligament; it passes downwards, and is inserted by a flat tendon, into the base of the first phalanx.

Relations.—It is overlapped by the preceding muscle, and lies on the adductor; the ulnar artery, and nerve, separate its origin from that of the abductor.

Action.—To flex; with but slight power.

Adductor, or Opponens, arises from the hamulus of the unciform bone, and annular ligament; the fibres pass inwards and forwards, and are inserted into the whole length of the metacarpal bone of the fifth finger.

Relations.—It is covered by the two former muscles, by the ulnar nerve, and artery; and lies on the internal interosseous, and metacarpal bone.

Action.—To adduct, with reference to the axis of the hand; but the opposite, with regard to the middle line of the body.

Lumbricales, are four in number, situated in the middle palmar space; each arises fleshy from the radial side of the corresponding tendon of the flexor profundus; the two external being also attracted to the anterior surface; they pass downwards, and terminate in round tendons, which run through the osteo-fibrous canal, between the heads of the metacarpal bones, in company with, but posterior to, the digital vessels, and nerves, and surrounded by a bursa: the tendon then becomes flattened, and passing obliquely backwards, is inserted, broad and expanded, into the extensor tendons, on the back of the phalanx of each finger.

Relations.—They lie on, and between the flexor tendons; behind the digital nerves, and vessels; and in front of the interossei.

Action.—To flex the first phalanx, also to keep the extensor tendons closely applied to the posterior aspect of the phalanges, thus acting in lieu of a sheath. According to some, their use is, to extend the fingers.

The flexor tendons, with the superficial arteries, and nerves, may now be thrown forwards, provided the latter have been fully examined; also the extensor tendons from the posterior aspect, preparatory to the dissection of the interossei, which are as yet covered by a strong aponeurosis, common to them, and the deep palmar vessels.

Deep Palmar Aponeurosis.—Irregular in shape, sometimes triangular, or it may be oblong; is attached behind to the anterior carpal ligaments, which it covers, their oblique fibres being visible through its semi-transparent tissue, and to the posterior layer of the carpal bursa, which is inseparable from it; as it passes forwards, it adheres to the ridges of the metacarpal bones; externally, separating the adductor pollicis, from the external interosseous muscle, and internally, the adductor minimi digiti, from the internal interosseous; anteriorly, it passes to the heads of the metacarpal bones, to be continuous with the deep half segment of the flexor thecæ, and here it is exceedingly dense and thick; in the interval between the metacarpal bones, it sends a process on the lumbricales tendons, which separates them from the interossei, and posterior to this point it is pierced by the branches of the deep arch of arteries, to join those of the superficial, and then becomes continuous, at the sides of the phalanges, with the superficial palmar fascia. Hence it follows that both those fasciæ represent a glove, containing in the cavity between them the superficial palmar arteries and nerves, and carpal bursa, with the flexor tendons, and the lumbricales, both the latter being invested in a sheath derived from the superficial surface of the deep layer, while the digital sheaths represent the fingers, the intervals between them transmitting the lumbricales, and digital vessels, and nerves. Its use is to preserve the position of the interossei; and further, to avert displacement of the metacarpal bones, while its density explains why matter, when situated in the palm of of the hand, cannot escape between the interossei, which it might otherwise do in the interval between the two sets of these muscles. We have described this process as a distinct structure, believing it to have surgical importance equally as great as the superficial layer has, in affections of this nature.

By now separating the anterior extremities of the metacarpal bones by a slight cut, and tearing them asunder, we expose the interossei, which are four in number behind, and four in front, the former being called the dorsal, and the latter the palmar. In both situa-

tions, however, to make up the four, the adductor pollicis in front, with the abductor indicis behind, must be considered as interossei, and these will be found described with the muscles of the thumb in a former section.

Posterior Interossei, are bicipital muscles, lying between the metacarpal bones of the four outer fingers; they arise by one side from the posterior and outer edge of the external, and all the internal surface, of the inner metacarpal bone; pass forwards, and terminating in a tendon at the metacarpo-phalangeal articulation, are inserted, the two outer, into the radial side of the first phalanx of the index, and middle fingers, and also into the extensor tendons on the dorsal aspect; and the two internal, into the ulnar side of the middle, and ring fingers, and extensor tendons.

Use.—To abduct the fingers from a supposed mesial line, corresponding to the middle finger.

Anterior Interossei, arise from the metacarpal bones on the same side to which they are attached, and forming a fleshy mass, with a penniform arrangement of the fibres, terminate in tendons which are inserted, the two outer into the ulnar side of the first phalanx of the thumb and index finger, and the two inner into the radial side of a similar point in the ring, and little fingers, and also into the extensor tendons; they lie on the dorsal interossei, which appear at their margins; and the perforating branches of the deep palmar arch, pass between them. It will now be seen that the posterior interossei are abductors, with reference to the mesial line of the hand as represented by the middle finger; while the anterior, are adductors to the same point.

DISSECTION OF THE LOWER EXTREMITY.

The subject should now be placed on the back, and raised by a block beneath the loins, in order to render the muscles of the anterior abdominal region tense; or a small puncture may be made through its walls, and the point of a blow-pipe having been introduced, sufficient inflation may be employed, to render the parts prominent, and more capable of dissection. Before, however, proceeding to remove the integument, it will be necessary to make a few prefatory remarks, and to define more especially what we mean by the anterior abdominal region. This term, is applied to that portion of the trunk, extending between the ensiform cartilage and pubis, varying however in comparative length at different periods of life,—in the infant, forming one-third of the entire extent of the subject; but in adult life, constituting one-fifth only, the difference being attributable, not to any absolute shortening of the cavity, but to the increase in the growth of the lower extremities and thorax

exceeding that of the abdomen. The anterior abdominal region, is bounded, above by the ensiform cartilage, costo-xiphoid ligament, cartilage of the last true, and of all the false ribs; inferiorly, by the crest of the ilium, Poupart's ligament, crest, and symphysis pubis; and posteriorly, by the anterior edge of the latissimus dorsi. If the abdominal wall was carefully dissected from its attachment, and extended, it would resemble in its outline a Maltese cross, narrow above, where it is placed in the xiphoid angle; constricted inferiorly, where it forms the pubic angle, but expanded and carved, on each side, where it is stretched between the last rib, and the crest of the ilium. Taken as a whole, the space is much wider above, than below, in the adult; but narrower inferiorly, in the infant at birth, in consequence of the small size of the pelvis, at this period of life; while the relative prominence also differs with age; in the infant, being exceedingly convex, because the cavity contains the bladder, and its appendages, suprarenal capsules, and the liver, both the latter being organs of great size at this period; but with the descent of the bladder, the gradual diminution of the liver, and the absorption of the suprarenal bodies, the hypochondria lose their convexity, and assume a slight concavity, visible below the cartilages of the ribs, the remainder of the cavity being also much less distended. But in middle and old age, the abdominal wall becomes again tense and prominent, in consequence of fatty depositions, within the omentum and mesentery; and on this, depends the greater frequency of hernial protrusions in infancy, and advanced life.

The Abdomen, is divided into regions or zones, each containing its own peculiar organs; and an acquaintance with these subdivisions and the corresponding contents is therefore of great importance in guiding the prognosis of the surgeon in wounds penetrating its cavity.

The three great zones into which the abdomen has been divided have been called the epigastric, mesogastric, and hypogastric; and in order to map out these regions, certain lines are drawn, so as to encircle the trunk horizontally; the first of these, would strike in its course, the base of the ensiform cartilage in front, and the spine of the tenth dorsal vertebra posteriorly, and would indicate the junction of the chest and abdomen; the second, would surround the abdomen, on a level with the cartilage of the ninth rib, constituting, between it and the preceding, the epigastric region; a third, passing round the cavity, on a line with the spines of the ilia, circumscribes, between it and the one above, the mesogastric; whilst all below it, is called the hypogastric. If a line be now drawn, from the cartilage of the ninth rib of each side above, to the corresponding ilio-pubal eminences below; those three regions will be each subdivided into three, the superior presenting the right, and left hypochondria, on each

side, and the epigastric, or scorbiculus cordis in the middle; the middle, the right and left lumbar, with the umbilical or mesogastric between them; and the inferior, the right and left iliac, with the hypogastric occupying its middle space. We will now proceed, to consider each of these individually.

THE EPIGASTRIC REGION, triangular in shape, with the base below, and the sides formed by the arches of the seventh, eighth, and ninth ribs, the ensiform cartilage projecting in its middle, contains the left lobe of the liver, pyloric end of stomach, the aorta, cœliac axis, and solar plexus, pancreas, vena cava, and v. portæ. The right hypochondriac lying beneath the last true and five false ribs, contains the right lobe of the liver, hepatic flexure of colon, pylorus, duodenum, the upper part of the kidney, suprarenal capsule, vena portæ, cava, and hepatic vessels. The left hypochondriac, which is bounded in the same manner, contains the spleen, cardiac extremity of the stomach, splenic vessels, and splenic flexure of the colon, upper part of the left kidney, and suprarenal capsu le, together with the tail of the pancreas.

THE MESOGASTRIC, or UMBILICAL, contains the transverse colon, the mesocolon, inferior transverse portion of duodenum, root of mesentery, and head of pancreas. The right lumbar, contains the ascending colon, kidney, and renal vessels, and in fœtal life, the testicles. The left contains the descending colon, kidney, renal vessels, and the testicle also in early life.

THE HYPOGASTRIC REGION, contains the small intestines, great omentum, or epiploon; and in fœtal life and infancy, the bladder. The right iliac, contains the cœcum, vermiform process, termination of the ileum, and frequently the convolutions of the small intestines. In the left iliac, are the sigmoid flexure of the colon, commencement of the rectum, the lower and left extremities of the epiploon, with some convolutions of the small intestines.

Three other regions, known as right and left inguinal, with the pubic between them, have also been described; but they more properly belong to the pelvic region. It may, however, be stated here, that while the inguinal contain the spermatic cords, inguinal peritoneal pouches, and hypogastric, and epigastric arteries; in the pubic, are found the bladder with its appendages, and the urachus, in early fœtal life.

We have thus considered, though perhaps, somewhat out of place, the several divisions of the abdomen, before discussing the anatomy of the contained organs; but we would in nowise desire the junior student to dwell on this description, until he has previously in some degree, made himself conversant, with the size, position, and attachments of the viscera; as thus only will he be able to appreciate the practical utility of the regional anatomy of this important cavity.

The Superficial Muscles of the Abdomen, consist of five pairs, —namely, external oblique, internal oblique, transversalis abdominis, rectus, and pyramidalis. To expose them, an incision should be made from the ensiform cartilage, to the pubis; and from the middle of this line, to the anterior superior spinous process of the ilium; when, the flaps may be reflected.

Superficial Fascia.—This subcutaneous layer, continuous with the similar structure of the regions in the vicinity, is thin above, but strong and laminated inferiorly, and contains a variable quantity of fat; white pale bands are also seen traversing its structure; and these are believed to have many characters in common with the unstriped muscle, but it is probable that they are simply fibrous tissue condensed into fasciculi. On the surface of the fascia, and between its layers may be seen cutaneous nerves, arteries, and veins, with a few lymphatic glands; while inferiorly it passes over Poupart's ligament, to which it is connected through the medium of Scarpa's fascia only. At the pubis, the laminar arrangement is well marked, where it passes on the penis, to form its false suspensory ligament; but in the female, it is loaded with firm adeps, and forms the mons veneris, descending externally to the labia majora; while in the male, it passes downwards on the cord to the scrotum, where it degenerates into areolar tissue. The superficial vessels and glands are, as we have said, placed between the laminæ of this fascia, which may be divided, by minute and careful dissection, into so many as five layers, and in all cases the rule would appear to be, that the greater the deposit of fat, the less visible become the fibrous bands, which appear under such circumstances to be weak and indistinct.

In connection with the fascia, several cutaneous nerves are seen, the lateral being branches from the six inferior intercostal, which pierce the external oblique, or escape between its indigitations, and then divide into a posterior, and anterior branch; the former, being reflected backwards, over the latissimus dorsi; while the latter, pass forwards, as far as the middle line, where piercing the anterior part of the sheath of the rectus, they form a plexiform interlacement, on the linea alba. The posterior cutaneous, derived from the ilio-scrotal, and last dorsal, have been already noticed with the lumbar region; and in addition, the scrotal branch of the ilio-scrotal and hypogastric branch of the ilio-hypogastric, escape through the external ring, or through the tendon external to that point, while the genital branch of the genito-crural also passes through the ring, but is not distributed to the integument of the abdomen, as the two former always are.

The cutaneous Arteries, are branches of the intercostals, with

perforating twigs of the deep epigastric, and mammary; in addition to which, three branches are also found on the surface, more or less regularly, namely, superficial epigastric, external circumflex ilii, and superior external pudic.

SUPERFICIAL EPIGASTRIC, arises from the femoral, about three-quarters of an inch below Poupart's ligament; it first passes forwards, piercing the sheath of the vessels, and cribriform fascia; then turning upwards, forwards, and inwards, passes over Poupart's ligament, from which it can be traced, to a point corresponding to the umbilicus, sending branches through the tendon of the external oblique, to communicate with the deep epigastric, and also with the inferior intercostals. This vessel is accompanied by two veins, which lie on either side of it, and which ultimately terminate in the curve of the internal saphena, immediately before it joins the femoral.

EXTERNAL CIRCUMFLEX ILII.—Smaller than the last, from which it sometimes arises, but is usually a branch of the femoral, springing from its outer side; it pierces the sheath of the vessels, and courses for some distance beneath the iliac portion of the fascia lata, which it ultimately perforates; then runs parallel to, but below, Poupart's ligament, giving off branches to the glands, and terminates at the crest of the ilium, by anastomosing with superficial branches of the internal circumflex ilii. Its accompanying veins have a similar termination to those of the last.

SUPERFICIAL PUDIC, consists of two branches—the superior, and inferior. The first, arises from the femoral, and, having emerged from the sheath of the vessels, superficial to the femoral vein, pierces the cribriform fascia, or pubic portion of facia lata; it then crosses the cord, and runs upwards over the spine of the pubis, supplying the mons veneris in the female, and the tegumentary layer of this region in the male, while it also gives off branches to the glands in the groin. The inferior branch, passes horizontally inwards, beneath the pubic fascia, until it arrives opposite the scrotum, when it pierces the fascia, to supply that struction in the male, and the labia majora in the female. The superficial pudic veins, likewise terminate in the saphena.

LYMPHATIC GLANDS, are from four to seven in number, and lie parallel to Poupart's ligament; the superficial lymphatic vessels from the genitals pass through them, and then course downwards, to communicate with the deep absorbents before entering the abdomen.

On raising the superficial fascia, a second layer becomes visible, originally described by Scarpa; it is dense, semitransparent, and devoid of fat, and can be raised as a distinct layer, or about four inches above Poupart's ligament. Following it downwards, in the middle

line it passes over the pubis, inclosing the penis in a tubule, and more externally investing the cord, which conducts it into the scrotum, from which it is continued backwards, to form the proper perinæal fascia, while still more externally it adheres most intimately to Poupart's ligament, and is finally attached in the groin to the cribriform fascia, which it separates from the sheath of the vessels; when this is removed, the external oblique is visible in its entire extent.

Obliquus Externus, or Descendens.—Flat and quadrilateral, but broader in front than behind, tendinous anteriorly and inferiorly, and fleshy superiorly and posteriorly, arises by triangular fleshy slips, from the eight inferior ribs, external to their cartilages; the five superior, indigitating with corresponding origins of the serratus magnus; and the three inferior, with those of the latissimus dorsi, which sometimes conceal them; the inferior fibres pass vertically downwards, and are inserted fleshy into the two anterior thirds of the crest of the ilium; the superior and middle pass obliquely downwards and inwards, to be attached to an aponeurosis, by which the muscle is inserted into the ensiform cartilage, linea alba, for its whole length, the anterior superior spine of the ilium, Poupart's ligament, the crest, and symphysis pubis. The aponeurosis alluded to, is somewhat triangular in shape, the widest portion being stretched between the iliac spines, but from those points to the pubis it becomes gradually contracted; while above the spines, it first diminishes in width, but again somewhat expands as it ascends; a line drawn, from the cartilage of the eighth rib, to the iliac spine, would indicate its external edge. The fibres which form the tendon, take an oblique course downwards, forwards, and inwards arranged in fasciculated bands; but inferiorly, as the pubis is approached, these are more or less separated, leaving an important opening *(the external abdominal ring)* in this situation, the fibres being inserted in three parts on the anterior surface of the pubis the first, decussating in front of the symphysis, and forming the ligaments of the penis; the second, forming flat bands, and gliding downwards over the symphysis and spine, not decussating, but attached to the pubic portion of the fascia lata; and the third, deep and decussating with each other, forming by their insertion into the upper part of the crest, and linea-ileo-pectinea, the ligament of Mr. Colles.

Relations.—This muscle is subcutaneous, and lies on the internal oblique, rectus, pyramidalis, and intercostals; while the posterior edge forms the anterior boundary of a triangular space, in which the internal oblique is seen, also the last dorsal nerve, and branches of the internal circumflex ilii; but it frequently occurs that the latissimus

dorsi, which constitutes the posterior boundary, wholly covers this space, and even in some cases overlaps the external oblique.

Action.—To compress the abdominal viscera, stimulating their peristaltic action, and assisting in the expulsion of urine and fœces; also to depress the ribs, as in expiration; to raise the pelvis in leaping, and likewise to rotate the body to the opposite side, during the sitting posture.

On the dissected tendons of the last-described muscle, there are many parts visible, to which the student should next direct his attention; namely, linea alba, linea semilunaris, and lineæ transversæ, umbilicus, square openings for the passage of vessels, external abdominal ring, and Poupart's ligament.

Linea Alba, formed by the union of the tendons of opposite sides, acts as a ligament connecting the ensiform cartilage to the pubis; it is narrow below, but wider above, and also more weak and depressed, presenting several small apertures, through which portions of fat may protrude, forming tumours resembling herniæ, which are named adipoceles. It often occurs that these become inflamed, and may even be subjected to operation in mistake for strangulated herniæ; but from the repeated observations of those engaged in anatomical examinations, it would appear that their pathological characters are not always very remote, as may be shown by drawing forward the fatty tumour, when a small portion of the parietal peritonæum is generally found engaged in the dilated aperture. We scarcely remember to have seen a single case of adipocele, without a variable quantity of peritonæum being engaged in forming part of the tumour, nor have we observed them at all except in the epigastric region. In consequence of the concentric development of the abdominal parietes, a deficiency is sometimes present above the pubis, and in such cases the anterior wall of the bladder is also absent, the margins of that viscus adhering to the abnormal aperture, and the pressure of the contents protruding the posterior wall, which forms a reddish spongy tumour, with the ureter opening on its surface. In such cases, the penis is either absent, or atrophied.

The operations of tapping the bladder above the pubis for retention of urine, for ascites, and for ovarian dropsy, are performed in the course of the linea alba. The high operation for lithotomy, had likewise a similar site, but this has now become obsolete.

Uses of Linea Alba.—To form a fixed point of insertion for the muscles of opposite sides, and to serve as a ligament to prevent over-extension of the spine in the lumbar region, where such a motion might be attended with most dangerous results.

Linea Semilunaris, is a whitish faint line, extending from the

cartilage of the ninth rib, to the spine of the pubis, and corresponding to the point at which the tendon of the internal oblique splits, where it is about to form the sheath of the rectus. In order to define its position in the living subject, a line should be drawn, from the umbilicus, to the anterior superior spine of the ilium ; and if this be bisected, a curved line drawn from the cartilage of the ninth rib, a little internal to the point of bisection, as far as the spine of the pubis, will nearly indicate its true situation. This is the place which has been selected for the evacuation of ovarian accumulations, but as the pressure of the contained fluid must always exercise such an influence as to distend considerably the abdominal wall, it must likewise produce corresponding displacement of the epigastric artery, which may, therefore be wounded; and consequently, surgeons are slow in adopting this method of proceeding, which may be attended with a fatal result.

LINEÆ TRANSVERSÆ, are three or four white lines, seen through the tendon of the external oblique, and are nothing more than tendinous intersections of the rectus abdominis ; one being situated on a line with the ensiform cartilage ; a second about an inch below it; and a third opposite to the umbilicus, while sometimes a fourth, and fifth may exist, but always below the latter point. It has been stated, that the existence of those transverse lines confers on the several portions of the rectus muscle, the power of acting, each, independently of the other, but although its peculiar nervous supply does in some measure seem to confirm this view, it still appears to require further corroboration for its support. There can, however, be very little doubt that they are the analogues of the abdominal ribs, found existing in the saurian animals.

UMBILICUS.—Situated in the linea alba, a little below its middle, appears as a depression in the adult subject, but when the integument has been removed, it becomes prominent as at birth. In fœtal life it transmitted the umbilical vein from the mother to the child, and the hypogastric arteries from the child to the placenta, as well as the urachus, and the omphalo-meseraic artery, and vein. The depression which ultimately remains, after the sloughing or ulceration of the cord, is attributed to the umbilical vein drawing the integument upwards and backwards, towards the liver, and the hypogastric arteries downwards and backwards, towards the internal iliac arteries, of which they are the continuation. In consequence of a portion of the intestinal tube being developed external to the abdomen, this opening is frequently the seat of congenital hernia ; and when it passes directly through the umbilicus, the tumor presents depressions on the surface corresponding to the vessels of the cord ; but in the adult form of umbilical hernia, it protrudes on either side

of the opening, or sometimes on both, when the tumor is divided in the middle by a septum. Its situation would naturally point to the colon, as forming its probable contents, but it may contain only omentum.

Openings of communication, generally of a square shape, are observed in various parts of the tendon of the external oblique, for the passage of vessels ; and these also may become the seat of ventral herniæ, when subjected to continued distention, and debilitating influences. But the more frequent cause of their production, may be thus explained. A gradual deposition of fat, may take place on the abdominal wall ; and from it, processes may be sent through those openings, which have the effect of dilating them. If now, from any cause, a sudden absorption of the adipose material should occur, those processes will also be removed, leaving the openings permanently enlarged and patulous, with consequent weakening of the parietes, at the points which they occupy.

Poupart's Ligament.—This fibrous cord, is formed by the folded inferior edge of the external oblique ; it has three attachments, the first, being to the anterior superior spinous process of the ilium, which it appears to embrace ; the second, to the spine of the pubis ; and the third, broad and expanded, into the linea ilio-pectinea. It is curved in its outline, the convexity looking downwards, outwards, and backwards, the curvature being preserved by the attachment to it of the iliac portion of the fascia lata, but can be obliterated by flexing and rotating the thigh inwards. The superior posterior edge is grooved, and gives attachment to the internal oblique, transversalis, and cremaster muscles ; while the posterior inferior surface is smooth, and forms the anterior boundary of the crural arch ; the inner half is the more horizontal, and about an inch from the pubis, becomes twisted to form Gimbernat's ligament. Between it, and the tendon of the external oblique, which is attached to its upper edge, a sulcus is formed, on which the spermatic cord rests. At the pubis, its fibres may be divided into the decussating, and the direct ; the former, cross the anterior surface of the symphysis pubis, beneath the insertion of the external oblique ; while the latter, stretching across the crest of the pubis, form a suprapubic ligament, with which the structure described by Mr. Colles is directly continuous. Though its attachment internally, is said to be into the spine of the pubis ; more properly speaking it only rests on that salient point of bone, for it is not inserted into it by any of its fibres.

Gimbernat's Ligament is triangular in shape, with an excavated base, looking outwards towards the crural ring, of which it forms the internal boundary ; the anterior edge is continuous with Poupart's ligament ; and the posterior, thin and sharp, is attached to

the linea ilio-pectinea, along which a narrow slip may be traced outwards, between the junction of the iliac, and pubic portions of the fascia lata, as far as the ilio-pubal eminence. The position of the ligament is nearly horizontal, one surface looking downwards, forwards, and outwards; and the other upwards, backwards, and inwards.

From an examination of the parts in this region, it would appear that in the formation of Poupart's ligament, the tendon of the external oblique became inflected, and then, turning upwards on the deep surface of the abdominal wall, forms the fascia transversalis, so that the internal oblique, and transversalis muscles are placed between two aponeurotic layers. Again, from the peculiar anatomical arrangements of this ligament, it will be seen, that the position adopted so as to cause its relaxation, must tend to facilitate the return of hernial protrusions that escape at any point of the crural arch; and also that pressure, in order to be effectual on the arterial trunk of the lower extremity, must be applied either above, or below it.

External Abdominal Ring.—In the present stage of the dissection, this ring is still obscured by Camper's fascia, or bands which differ in density in accordance with age, as well as with the general structural development of the fibrous tissues. If the tendon of the external oblique is examined, on a level with the anterior superior spine of the ilium, white silvery fibres can be recognized, crossing in gentle curves, with their concavities directed upwards and outwards, the fibres of the subjacent tendon, resisting however, any attempt made to raise them as a distinct layer, as they appear to be incorporated with the tendon itself; but as the ring is approached, the distinct fibrous arrangement disappears, and at the margins of that opening, it is sufficiently loose in its attachment, to admit of its being raised by cautious dissection; passing downwards on the cord, in the male, or its analogue, the round ligament of the uterus, in the female, in the one, it is continued into the scrotum, and in the other to the labia, under the name of the external spout-like fascia; forming in the male the external investment for the tunica communis of the testicle, and serving to retain the expanded cremasteric fibres in their natural connexion to each other. If this fascia is now raised and the ring examined, an accurate dissection, will at once show that in the majority of subjects, the first separation of the fibres of the tendon of the external oblique, occurs above the middle of Poupart's ligament, and from this it gradually increases until the pubis is reached; the space, thus left between the diverging fibres, is covered by the intercolumnar bands, or Camper's fascia, which not only strengthen the wall of the abdomen in this situation, but likewise form, on leaving the tendon, a funnel-shaped process (infundibuliform fascia); and

on laying this open the ring is fully exposed. From this description it is evident, that the extent of the opening is merely arbitrary in the vertical direction; and although it is customary to consider the ring as triangular, with its base inferiorly and internally at the crest of the pubis, and the apex above and without, still if the proper attachments of its constituents ought to form the basis of its anatomical delineation, it will be necessary to examine its condition both on, and above, the pubis. Under those circumstances, it will be seen that this opening will represent an ellipsoid or oval figure, placed obliquely with one cornu directed upwards and outwards, and the other downwards and inwards; the formation of the superior cornu is sufficiently intelligible from the previous remarks on the separation of the fibres ; but the inferior, is formed by the non-decussating insertion of the pubic fibres of the tendon, overlapping and crossing at an acute angle the decussating insertion of Poupart's ligament into the symphysis. This oval ring, divided into a pubic portion, on which the spermatic cord lies, and a suprapubic, through which it passes in its transit from the inguinal canal to the scrotum, presents an internal and external pillar ; the internal being also superior and anterior, and consisting of the flat, thin, non-decussating band of the tendon; while the external, also posterior and inferior, is not, as Dr. Harrison states, thick and round (see *Dublin Dissector*), but really is composed of two very dissimilar parts, being, in the external two-thirds, thin and sharp, and formed in this situation by the oblique aponeurosis passing downwards beneath the cord, to become attached to the termination of the iliac portion of the fascia lata, where the latter is reflected downwards on the surface of the pubic portion, to constitute Colles's fascia ; while the internal third only, is thick, rounded, and concave, formed in fact by Poupart's ligament as it passes to its pubic attachment. The base of this opening corresponds to the crest of the pubis, but covered by the non-decussating fibres of Poupart's ligament ; and it is on the angle of the external pillar, where the thick and thin divisions unite, and not on the so-called base, that the cord rests. The ring measures in the male, from base to apex, one inch, or sometimes an inch and a quarter; but in the female its dimensions are much less ; in the male it is traversed by the cord, and its cremasteric covering ; and in the female by the round ligament of the uterus ; in both, the branch of the spermaticus superficialis escapes through the superior angle, and the genital branch of the genito-crural through the lower, beneath the cord ; while the ilio-hypogastric branch pierces the tendon higher up, or, in some rare instances, may pass through the ring itself.

An incision may now be carried, from the cartilage of the ninth

rib to the spine of the pubis; and another prolonged backwards through the muscle to its posterior edge, when, on reflecting the flaps, the internal oblique will be exposed.

Obliquus Internus, or Ascendens.—Somewhat quadrilateral in shape, but wider before than behind; tendinous anteriorly and posteriorly, but fleshy in the centre; arises from the anterior edge of the lumbar fascia, from all the crest of the ilium, from the two iliac thirds of the inner surface of Poupart's ligament, which is grooved for the reception of its fibres. The iliac, and lumbar portions, pass obliquely upwards, forwards, and inwards; and those from Poupart's ligament, curve downwards and inwards, arching in their course over the spermatic cord, and are inserted into the points of the cartilages of the six inferior ribs, ensiform cartilage, linea alba, crest of pubis, and pectineal line as far as the base of Gimbernat's ligament, becoming at this point intimately blended with the transversalis, and both in combination forming the conjoined tendons. This muscle, at the linea semilunaris, forms an aponeurosis, which splits into two laminæ to enclose the rectus; the layer which passes behind that muscle, becoming continuous with the aponeurosis of the transversalis; and that in front, with the tendon of the external oblique, thus forming a sheath to enclose the rectus, but only for its superior three-fourths, for in the mid-space, between the umbilicus and pubis, the four leaves of aponeurosis pass in front of the muscle, and become intimately incorporated with each other inferiorly. This aponeurosis, which is broader superiorly and inferiorly, than in the middle, is attached, superiorly to the cartilage of the last true and first false rib, and the ensiform cartilage; and inferiorly, to the crest, and linea innominata of the pubis.

Relations.—It is covered by the external oblique, and latissimus dorsi; but a small triangular portion is seen above the crest of the ilium, between the last-named muscles, and here the scrotal branch of the ilio-scrotal nerve, and the superior gluteo-cutaneous from the last dorsal may be observed. It lies on the transversalis, internal circumflex ilii, and twigs of the lumbar arteries, with the inferior intercostal nerves. Near to the spine of the ilium, the inferior fibres of this muscle are arched over the cord, this margin in the male being closely incorporated with the cremaster, but in the female its limit is obscurely defined. The conjoined tendon consists of the aponeurosis of the internal oblique, and transversalis; and from it, the external oblique can be separated with the handle of the scalpel, but the tendons themselves, forming it, are so closely incorporated, that even by dissection it is impossible to produce a separation; in examining their pubic attachment, that portion which is inserted into the symphysis lies in front of the pyramidalis, and

rectus; and at the linea innominata, Poupart's and Gimbernat's ligaments, are in front of them. It is usually considered, that the tendon extends only so far out as the base of Gimbernat's ligament, but such is not the case, as the external margin is prolonged outwards, over the deficient abdominal wall, thus strengthening the fascia transversalis in this situation. If the rectus muscle is raised, the point, where the aponeurosis ceases to form a posterior sheath for it, is marked by a semilunar tendinous edge, but this is not well defined, as Dr. Harrison remarked; as it invariably, sends down a prolongation on the peritonæum, and fascia transversalis; and occasionally, even a second lunated margin may occur, two inches below the first, but more faintly marked, indicating that the aponeurosis merely becomes weaker on the posterior surface of the muscle, but is not absolutely deficient at any point. If the muscle be now raised, in a manner similar to the former, the transversalis abdominis, rectus, and pyramidalis will be seen; these, with the cord and transversalis fascia, forming the deep relations of this muscle; but if it is a male, let the cremaster be first dissected, and in order to see it properly, all the superficial coverings of the cord, in the region of the scrotum, must be removed.

Cremaster, arises from the lower margin of the internal oblique muscle, and frequently from the transversalis, as well as from the outer half, and upper edge, of Poupart's ligament; the fibres descend in loops, with the concavities directed upwards, on the anterior and external part of the cord, and at the tunica vaginalis it expands between the external and internal spout-like fasciæ to form the tunica communis; it then ascends on the posterior surface of the cord, and epididymis, adhering to the latter, and is ultimately inserted into Poupart's ligament, where it covers the spine of the pubis.

Relative Description.—This muscle surrounds the testicle, but its anatomy is extremely variable. The looped arrangement, attributed by Cloquet to the impulsion of the fibres of the internal oblique, into the scrotum, by the descending testicle, is rarely visible; and even when such is the case, it merely forms a portion of the cremasteric apparatus. More frequently it consists of fasciculated plates of muscular fibre, varying in number from one to five; and as those bands arise, from the internal oblique, and Poupart's ligament; when numerous, they often unite at the inferior third of the cord, to form a perfect cylinder for its inclosure; but when a single band only exists, it always lies on the anterior part of the cord, beyond which the fibres cannot be traced. If, however, two bands occur, one is found lying anterior and external, and this is invariably the stronger; while the other, on the internal and posterior aspect,

is generally weak and pale, and has been observed to terminate in the globus major of the epididymis. The loops of Cloquet, in some rare instances, may be seen stretched between these bands; or, the cremaster may terminate at the external ring, although the testicle is normal in situation, as occurred in a case which came under our own observation. The tendinous insertion, is sometimes well marked, broad, and of a silvery lustre; but the cord must be raised to see it perfectly; yet it should be borne in mind, at the same time, that it may terminate on the pubic fascia, before reaching the bone at all. In short, it is not always a constant structure, nor can a continuity of tissue be invariably traced, between the fleshy fibres with which it is connected, and those at the bottom of the scrotum. It may also exist on the back of the cord, independent of any muscular tissue, and even be wholly unconnected with it, although some may be present. On this account, we conceive it to be merely a ligament to preserve the position of the cord on the pubis, and regard as being correct the views of Cloquet respecting the formation of the cremaster —those views being supported by many facts, that may be shortly stated as follows:—That the testicles extend the fibres of the internal oblique into the scrotum, to form the cremaster in their descent, is proved by the continuous attachment of the internal oblique to Poupart's ligament, in the fœtus prior to the descent of the testicle; and where the organ has never descended in the adult, the same attachments of the oblique will still be observed. In the female, likewise, the connexion to the ligament is almost complete, with the exception of a small space for the round ligament, on which a rudimentary cremaster is formed. It is, however, only fair to state, that there are objections to these views equally as forcible, namely, that the cremaster has been found in the scrotum, where the testicle had not descended (Cooper); and Curling has even seen the cremaster ascending, to be attached to the testicle in the abdomen; but this subject will be recurred to hereafter.

Action.—The internal oblique compresses the abdominal viscera, assists in the expulsion of urine and fæces, and also rotates the body to its own side, and bends it forwards; while the cremaster raises the testicle, and urges the semen in its course through the vas deferens; its action in producing the vermicular motions of the gland, during the venereal orgasm, is however very doubtful.

Transversalis Abdominis.—Similar in figure to the last-described muscle, arises tendinous from the lumbar fascia, from all the crest of the ilium in front of the attachment of the ilio-lumbar ligament, by triangular aponeurotic slips from the inner surface of the cartilages of the last two ribs, and by fleshy bands from the succeeding five, where they indigitate with the origins of the diaphragm; the

fibres pass forwards, the inferior curving downwards, the middle transversely, and the superior upwards, and terminate in an aponeurosis sooner than those of the internal oblique, with which it is united at the linea semilunaris, to be inserted into the ensiform cartilage, linea alba, pubis, and linea ilio-pectinea. Mr. Guthrie describes the cord as passing through a ring in this muscle, which may be thus expressed :—That the fibres arising from Poupart's ligament take their origin beneath the cord, passing at first upwards and outwards, and then curving downwards and inwards to reach the conjoined tendons; in fact, describing an elliptical aperture with an inferior pillar, concave, and a superior, straight: this arrangement, however, is not always present; but careful dissection will show, that it certainly does exist in the majority of subjects, although not equally well marked in all.

Relative Anatomy.—The relative anatomy of the lumbar fascia, which must be regarded as the aponeurosis derived from the posterior edge of the transversalis, has been already fully described in our observations on the lumbar region, and therefore requires no further comment here. The muscle is covered by the internal oblique, by the upper portion of the rectus, and intercostal nerves, as they run forwards to reach the sheath of the latter muscle; by the ilio-scrotal, and ilio-hypogastric nerves, which pierce its iliac origin; and by the internal circumflex ilii artery, which courses along the crest of the ilium, between it and the internal oblique. It lies on the lower portion of the rectus, on the fascia transversalis, peritonæum, and on the cord.

Action.—Similar to the last muscle.

Rectus Abdominis.—In order to see this muscle, the fibrous layer should be dissected from its surface; an operation difficult to accomplish at the tendinous intersections, but one that can be effected with facility in the interspaces between them. In its general appearance it is flat, and wide above, but thick and rounded below; arising from the upper part of the crest of the pubis by an oval tendon, which is sometimes bifid, with the fleshy fibres commencing on its posterior aspect: it passes upwards and slightly outwards, and is inserted by three bands—the internal, short and wide, into the side of the ensiform cartilage, the middle into the cartilage of the sixth, and the external, longer and narrower, into the cartilage of the fifth rib; this last slip is occasionally continued upwards to the great pectoral, and uniting with its external fibres, may even pass as high as the anterior lip of the bicipital groove of the humerus.

Relations.—It is covered by the anterior layer of the sheath, and by the pyramidalis. It lies on the posterior layer of the sheath, fascia transversalis, epigastric artery, abdominal branch

of the internal mammary; and on the sixth, and seventh internal intercostals.

Action.—In consequence of the tendinous intersections which have been before alluded to, it has been supposed, that the several divisions of the muscle can act in separate sections, from above downwards, so as to force the contents of intestines towards the outlet of the body. These intersections are sometimes not complete, as the fibres on the posterior surface of the muscle may be continuous from the ensiform cartilage to the pubis; but this is certainly the exception. Still they are undoubtedly not so evident on the deep, as on the superficial surface of the muscle, and are probably, as we have before observed, the analogue of the abdomino-costal bones of reptiles; while the long fibres may also be regarded, as analogous to the long intercostal muscles. Its general use is to depress the ribs, to prevent over extension of the trunk on the pelvis, and to assist in leaping.

Pyramidalis Abdominis.—A small triangular muscle, lying in front of the origin of the rectus; arises from the crest of the pubis, and passing upwards and inwards, for about an inch and a half, is inserted into the linea alba, with which it is intimately connected, and through which it is indirectly attached to the ensiform cartilage.

Relations.—In front of it are the external oblique, Colles's ligament, and conjoined tendons, and behind it the rectus abdominis. It is very often wanting, or its position may vary.

Action.—To make tense the linea alba.

Arteries in the Abdominal Wall, are the internal mammary, deep epigastric, and circumflex ilii; with the trunks of the inferior intercostals. The abdominal branch of the internal mammary artery, enters the abominal wall through a triangular space between the costal and xiphoid origins of the diaphragm, passes into the sheath of the rectus; and a little above the umbilicus, anastomoses with the deep epigastric.

Internal Epigastric.—A branch of the external iliac, passes upwards in the posterior part of the sheath of the rectus, and anastomoses with the abdominal branch of the mammary.

Internal Circumflex Ilii.—Also a branch of the external iliac; passes between the external oblique, and the transversalis at their iliac attachments; and anastomoses with the lumbar, ilio-lumbar, and gluteal arteries.

Intercostals.—The six inferior pass forwards, between the internal oblique, and transversalis, and terminate in the rectus; such being also the termination of the corresponding nerves: but for a more detailed description, see Vascular System.

The student should now direct his attention to the anatomical region concerned in the production of *hernia*, and this can be accomplished on the opposite side of the abdomen, which should be left entire, for that purpose, in the inferior third. A *hernia*, is defined to be a protrusion of a portion of the contents from either of the three great cavities of the body, namely, the head, chest, or abdomen; with the last of which only, we now propose to deal, and will commence by stating that the escapement may consist of either intestine (enterocele), or omentum (epiplocele), or of both in combination (entero-epiplocele). In the normal condition of the parietes, a reciprocal interchange of pressure subsists between the containing parts, and those contained; but when the pressure from without, as in violent muscular efforts, or the pressure from within, depending on augmented volume of the viscera, becomes inordinate, the weakest portions of the walls yield to the impulse, and either suddenly give way, or gradually permit portions of the contents to escape from within the natural limits of the cavity. Those weaker points are usually found in the situations where openings occur, for the transmission of parts either into, or out of the cavity,—usually, we say, because wounds, congenital deficiencies, or relaxations, may frequently render the walls less capable, than even the sites of fœtal openings, of resisting protrusions. In the inguinal region, a superficial, and a deep opening are present for the passage of the elements of the spermatic cord; but nature, in the fashioning of those patulous parts, has exhibited an exquisite perfection of art, by placing an oblique canal between the two rings, so that the greater the amount of pressure, provided it does not exceed certain limits, the more security is afforded against protrusion, by the approximation of the opposite walls of the intervening space. If a line is drawn, from a point three inches below the umbilicus to the anterior superior spinous process of the ilium, and if Poupart's ligament be adopted as the inferior boundary, and the linea alba as the internal, such will be the space, or inguinal region connected with the surgical anatomy of this important lesion.

The integument of the inguinal region, is fine and movable on the subjacent fascia, but somewhat more adherent to the line of Poupart's ligament; on raising it, the superficial fascia is seen, more or less aponeurotic in its character, and containing a variable quantity of adipose tissue, glands, and superficial vessels; immediately beneath it, Scarpa's fascia constitutes the third layer; the external oblique tendon, with Camper's fascia, representing the fourth; the internal oblique, with the cremaster, the fifth; the transversalis abdominis, the sixth; and the fascia transversalis, and subperitonæal tissue, with the peritonæum, the seventh stratum of tissues superimposed in this region. When the integument and fasciæ have been

removed, the external ring becomes apparent, and this is easily appreciable even in the living subject, immediately above and a little external to the spine of the pubis. In consequence of the peculiar arrangement of the external spout-like fascia, a temporary obstacle to the escape of a hernial protrusion is produced, but the continued pressure gradually expands the pillars of the ring, and as the thin portion of the external is forced outwards, the internal as gradually yields in the upper direction, becoming thin, and expanded, the edges being prolonged on the tumour for some distance; when the ring represents a funnel, with the apex free, and with the base turned towards the cavity of the abdomen. When the external oblique tendon is thrown down cautiously, a space is observed in which the spermatic cord, or round ligament, is lodged, extending outwards to the point where such part emerges from the cavity; this space, known as *the inguinal canal*, is of a prismatic form, with the base corresponding to the abdominal edge of Poupart's ligament, its direction being obliquely downwards, forwards, and inwards; its anterior wall is formed by the tendon of the external oblique, in its whole length; in the outer half, by the internal oblique; and in the external third, by the transversalis abdominis; so that in the internal third, the tumour is most superficial, being covered only by the superficial layers and oblique aponeurosis; but as we approach the internal ring, the inferior fleshy margins of the internal oblique, and transversalis, overlap the canal, and augment the coverings of a hernia, in this division of it; its posterior wall is constituted by the conjoined tendons, Colles's ligament, fascia transversalis, and internal epigastric artery; while below, we have Poupart's ligament; and above, the apposition of its opposite walls. This canal measures, between the distal margins of the rings, an average of three inches; and between the proximal, two; these measurements having been deduced, as the mean, from seventy-two cases examined. In the fœtus, however, the rings are nearly antero-posterior, in consequence of the non-development of the horizontal rami of the pubis; but as life advances, the internal ring moves outwards, coincident with the development of that bone. Again in the female, the canal is proportionately increased in length, owing to the width of the pelvis, so remarkable a characteristic of that sex.

The student should now turn to the opposite side, which has been dissected, and observe, that on the removal of the muscles, the peritonæum is covered by a strong fibrous membrane, first described by Sir A. Cooper as the transversalis fascia, which is attached to the inner lip of the crest of the ilium, to Poupart's ligament for its whole length, and then, meeting with the outer edge of the rectus abdominis,

becomes intimately adherent to it, and is further continued on its posterior surface to unite with the similar sheet of the opposite side. At the crest of the ilium, it is connected with the iliac fascia, and this junction continues as far inwards as the external iliac artery, a whitish line parallel to Poupart's ligament marking their union, which, in fact, constitutes the canal for the transmission of the internal circumflex ilii artery, and its two accompanying veins; inferiorly, this fascia is strong; but as it ascends, it becomes much weaker, until it is at length confounded with the subperitonæal areolar tissue; while from Poupart's ligament, a process is sent downwards, into the femoral region to form the anterior half of the sheath for the femoral vessels.

In order to find the internal abdominal ring in the living subject, a point, midway between the anterior superior spinous process of the ilium and the symphysis pubis, must be selected; and three-quarters of an inch above Poupart's ligament, will indicate its exact position; but it must not be regarded as a defined aperture, even when examined on its deep or peritonæal surface. When the fascia transversalis is torn from the latter, the elements of the cord are seen diverging at an acute angle, the course of the vas deferens being inwards and backwards; whilst the spermatic artery, and vein, ascend with a very slight degree of obliquity, upwards and inwards. At the site of the ring, a mass of areolar tissue, occasionally fatty, and extending downwards and backwards, on the external iliac artery, indicates the remains of that process of peritonæum which formed the tunica vaginalis, and when this is cautiously removed, the position of the cord shows the situation of the internal ring. We cannot, however, exactly agree with the anatomical description given of this part in the usual works on the subject, as any definite figure which it may be made to present, is purely artificial, unnatural, and delusive, fashioned with the scalpel, rather with a view to accommodate nature to descriptive prolixity, than with the effect of describing structures as they really exist, in the subject. The opening appears simply as a vertical slit on the abdominal surface of the fascia transversalis, the external margin being strong and lunated, while the internal is not so well defined, but appears to be much thicker than the former. The deeper part of the internal ring is fully half an inch distant from the internal epigastric artery, and should be styled its abdominal aspect; for both the vas deferens, and the spermatic vessels, pass for about a quarter of an inch, between the layers of the fascia transversalis, before they pierce the external sheet, which is prolonged on the cord to the scrotum, constituting what has been termed, the internal spout-like fascia of the spermatic vessels. The peritonæum should now also be examined, and its peculiarities noticed in the abdomino-inguinal region, as in this

situation the surface is irregularly concave, forming the internal, and external inguinal pouches, on each side. The external pouch, triangular in figure, occupies the space between the anterior superior spine of the ilium, and the epigastric artery; this, it is believed, predisposes to the formation of the oblique form of inguinal hernia; while the internal, quadrilateral in its outline, and bounded internally by the urachus, and externally by the epigastric artery, is again subdivided, by the obliterated hypogastric artery, into an external smaller, and an internal larger space; of these, the external division is subject to extreme variety in size, and even as to existence, these variations depending on the course of the hypogastric, with relation to the epigastric artery; as sometimes they are so close, as to be absolutely in contact with each other; or again, a space varying from a quarter to three quarters of an inch, may intervene between them; and this even in the female, for the increased width of the bladder in her case, can produce no displacement of the obliterated artery, as it is more than compensated for by the augmented capacity of the pelvis, and the greater elongation of the inguinal canal. Should a protrusion occur through the external division, it constitutes the external direct inguinal hernia of Mr. Guthrie, whilst a similar escape through the internal division produces the ordinary form of direct inguinal hernia, or the internal direct of the same author. These differential characters, are however, of but very trivial importance; although it is true, that the external direct, possesses a cremasteric covering, which is absent in the ordinary form; but still the position of both remains the same in relation to the epigastric artery, and this seems to us the most important point in a practical sense, which the student should seek to impress on his mind.

We have thus noticed, somewhat in detail, the anatomy of those parts concerned in the production of inguinal hernia; but as there occur two forms of this accident, each with different anatomical relations, we will now proceed with their individual peculiarities. An oblique inguinal hernia, in protruding at the internal ring, carries before it a portion of the peritonæum, which lines the abdominal wall, and this constitutes the sac; it then, on emerging from the ring, receives an investment from the internal spout-like fascia, which is, as we have already explained, a prolongation from the fascia transversalis, forming what has been termed the tunica, or fascia propria, of the hernia; it next lies beneath the fleshy margin of the transversalis, when that muscle arises as far inwards as the centre of Poupart's ligament; or it splits it, when that peculiar arrangement of the lower fibres exists as described by Mr. Guthrie; it then lies beneath, or under cover of, the fleshy margin of the in-

ternal oblique, and as it further pursues its course towards the external ring, it insinuates itself beneath the cremaster, in the male subject; still farther in, it is covered only by the tendon of the external oblique, and, escaping through the external ring, it receives a tubular sheath from the intercolumnar bands, or external spout-like fascia, then Scarpa's layer, superficial fascia, and the integument; from the external ring we find it pursuing its course into the scrotum, and in that cavity it lies, with the spermatic cord behind it, and the testicle, and tunica vaginalis at its inferior part, the tumour being closely related to the epididymis. It will be observed, that the direction of the hernia is downwards, forwards, and inwards, following the course of the inguinal canal, and spermatic cord, the latter lying immediately below and posterior to it; but where the protrusion is large, and has existed for a long period, the deep ring is carried inwards, and the external pillar of the superficial ring, yielding in the outward direction, the two openings are approximated, and the inguinal canal shortened, with a consequent diminution of the obliquity, characteristic of that sort of hernia of which we speak, so that it becomes often impossible to determine the nature of the case, from the mere course of direction. Connecting this circumstance with the close relation of the internal epigastric artery, which in recent and small protrusions, lies only a quarter of an inch internal to the neck of the sac; but in old forms is in much closer proximity to it, in many cases presenting a concavity, into the outer side of which the hernia is received, we may better appreciate the advice of Sir A. Cooper, who proposes that in all cases, where it is difficult to discriminate whether the protrusion is by the oblique, or by the direct descent, to cut directly upwards when dividing the stricture, as by this means, the danger of wounding the vessel, if not positively avoided, would be at least sensibly diminished.

Now replace the coverings which have been raised, and examine the parts which must be divided, in an operation for the relief of a strangulated inguinal hernia by the oblique descent; these will be found to be—integument; superficial, and Scarpa's fascia; Camper's band, or external spout-like fascia; cremaster; fascia propria; and peritonæal sac, with a small portion of the tendon of the external oblique, above the external ring. The incision should commence a little above the external ring, and be carried downwards and inwards, in the axis of the tumour, for about two and a half inches. Each covering must be divided cautiously, by raising a portion with the forceps, and then making a small aperture with the knife held horizontally, and subsequently introducing the director, so as to divide each successive layer, to an extent equal to that of the original

incision. According to the number of layers divided, so should the caution of the surgeon increase; for although, as a general rule, the coverings are thickened, there are exceptions, one of which we observed in a case operated on by Dr. Jameson in Mercer's Hospital, where they were so attenuated, that the sac was exposed by the removal of two layers only. Having arrived at the sac, which is recognised, in the majority of cases, by its smooth and free surface, the question of opening it, or otherwise, may now be determined; and if the former mode is adopted, a small opening may be made, in the manner before described, at the lower part or fundus, as the fluid that is within the sac, gravitating to its most depending point lessens the danger of wounding the intestine. Having now opened the sac, the finger should be introduced, or if that cannot be accomplished, a probe will generally enter the cavity of the abdomen, if the sack has been fairly opened; having determined this point, the forefinger of the left hand, with Sir A. Cooper's hernia-knife placed flat upon its surface, should now be introduced up to the stricture, which should be divided in a direction either upwards, or upwards and outwards, to avoid the epigastric artery. It should, however, be always borne in mind, that although the cord usually lies behind this form of protrusion, still, from long-continued pressure, or other causes, the position may become altered, and the spermatic vessels may lie on the forepart, and the vas deferens behind the tumour, as in "dissecting hernia." In the course of our dissections, we have seen an instance, where the whole cord lay in front of the tumour; and another, where the vas deferens was internal, and the spermatic vessels on the external side of the intestine—exceptional cases no doubt, but still calculated to impress forcibly the necessity of caution, in all operations of this nature.

In the direct form of hernia, the intestine escapes through that space, which is bounded externally by the internal epigastric artery, internally and superiorly by the conjoined tendons, and inferiorly by the crest of the pubis, and Poupart's ligament; the parts tending to avert protrusion in this space being—the conjoined tendons, outer edge of the rectus tendon, Colles's ligament, and the spermatic cord stretched across its forepart. The internal direct form, which escapes internal to the hypogastric artery, and external to the urachus, when passing from the abdominal cavity, carries before it, first—the peritonæal sac; secondly, a fascia propria, derived from the fascia transversalis; and occasionally, an expansion from the outer edge of the conjoined tendons; it next passes through the external ring, lying internal and superior to the cord; but it should be remembered, that this relation is not always uniform, as we have seen it emerge below and external to it, and have even observed the

constituents of the cord spread out over its superficial surface, as an additional covering, in its descent towards the scrotum. Under all circumstances however, when it once protrudes, it is covered in succession by the internal spout-like, Scarpa's, and superficial fasciæ, and lastly by integument. But in the external direct, which protrudes on the outside of the hypogastric artery, and internal to the epigastric, the hernia has a cremasteric covering, which lies between the external spout-like, and the fascia propria. It should always be borne in mind, that the epigastric artery lies to the outer side of the neck of a direct inguinal hernia; and that in some old cases, the hernia enlarges its opening of escape, upwards and outwards, so that this vessel may cross it superiorly, in its course to the rectus sheath. We therefore doubt if it would be wise in such a case, or even safe, to cut the stricture directly upwards. Let the student now reflect, as to where stricture is likely to ensue, in those herniæ we have just described. In an oblique inguinal hernia, it may be caused within the sac, by the intestine passing through openings in the contained omentum, or by bands of lymph crossing the sac; next in order, it may occur at the external abdominal ring,—this usually being the the seat of strangulation, in old and large herniæ,—or it may occur at the fleshy margin of the internal oblique, and transversalis muscles; or lastly, at the neck of the sac itself. In the direct form, the stricture is generally seated at the latter situation.

Congenital Hernia, is that form of protrusion which takes advantage of the patulous state of the inner ring, requisite in fœtal, or early infant life, for the descent of the testicle into the scrotum. It usually occurs between the sixth and ninth months of gestation, but most frequently at the latter period, owing to the pressure to which the abdomen is subjected during the efforts of parturition. It descends directly into the cavity of the tunica vaginalis, lying when fully formed in front of the cord and testicle, having followed the exact course of an oblique inguinal hernia, but being devoid of a peritonæal sac, except what it receives from the vaginal tunic. But if it takes place after birth, the internal ring becomes partially closed by the effusion of plastic lymph; and if, while this material remains soft and yielding, a portion of intestine presses against it, this plastic effusion is prolonged as a membrane before the hernia, thus producing the "infantile hernia," which lies also within the cavity of the tunica vaginalis, but with this adventitious covering immediately surrounding it, or, as Mr. Hey expresses it, "there is a sac within a sac." The late Mr. Todd, of the Richmond Hospital, has, however, offered a different explanation of this hernia, not indeed very easily understood, but perfectly consistent with anatomical considerations. He believed that the intestine inflects that portion of peritonæum

that covers the posterior surface of the cord, and prolongs it as a sac behind the spermatic vessels, and that portion of peritonæum which is to form the tunica vaginalis. Thus, when it has descended so far as to reach the testicle, three layers of serous membrane would lie anterior to the intestine, namely, the tunica vaginalis of the scrotum, that of the testis, and the inflected layer; but posteriorly, only one, the back part of the inflected sac. In this way, it would possess a peritonæal sac, which Mr. Hey denies. This question is one of some practical importance, as it involves the propriety of making the incision in the anterior, or posterior part of the scrotum. Mr. Todd recommends, when such a protrusion becomes strangulated, to cut down on the back part; as, if his explanation is correct, only one layer of serous membrane intervenes, while Mr. Hey advocates the anterior incision. We have not, however, seen this particular form of rupture dissected, and cannot therefore, offer an opinion on the subject.

ORGANS OF GENERATION IN THE MALE.

Testicles, perinæum, penis, bladder and its appendages; such is the order of dissection, to be pursued in the examination of the generative organs; but with the testicles, should be grouped the vesiculæ seminales, vasa deferentia, Cowper's glands, and probably the prostate; but as these appear in different stages, it will be preferable to examine each as it is exposed, rather than connected as a system; and with the anatomy of the individual organs, their functional relations to each other, will likewise be explained.

The Testicles are symmetrical organs, situated in a loose, pendulous bag of the integument, called the scrotum. To within a short period before birth they occupied the abdominal cavity, where their development was completed from the Wolffian bodies; but at the fifth month, each testicular gland lies beneath the kidney, on the quadratus lumborum muscle, above the gubernaculum testis, and behind the peritonæum. In order however, to understand the descent of those glands, the gubernaculum testis should be examined in the fœtus; at present it will be sufficient to remark, that the gubernaculum is a triangular fibrous canal, containing in its middle a gelatinous fluid, the base superiorly receiving the inferior extremity of the testicle like a cup, and the apex inferiorly attached to the spine of the pubis, or more correctly to Poupart's ligament, and from thence sending a thin process downwards into the scrotum. Both the superior, and inferior portions are inclosed by the cremaster, to the gradual contraction of which, and the shortening of the gubernaculum, the slow descent of the glands is attributed. Thus, in the fifth

month they have reached the iliac fossa; in the sixth, they are at the internal ring; in the seventh, in the canal; in the eighth, at the external ring, or upper part of the scrotum; and in the ninth, in the position they are ultimately to occupy. Sometimes one of these organs fails to reach its proper situation, as it may be arrested in the abdomen, in the canal, in the external ring, or in the superior part of the scrotum; or, as in a case which we recently examined, the organ may descend too far, where it was found beneath the integument of the perinæum; or the movement may be delayed even to the adult period. See case of Undescended Testicle, by Mr. Hamilton, of the Richmond Hospital, in the *Dublin Quarterly Journal*, for May, 1852.

In the examination of the scrotal region, the following coverings are exposed:—1. Integument, or scrotum; 2. Dartos; 3. Areolar layer; 4. Scrotal fascia; 5. Tunica communis; 6. Tunica vaginalis of scrotum, and of testis; 7. Tunica albuginea; 8. Tunica vasculosa.

The Integument, is loose, fine, and rugated, of a dark brown colour, and studded with a few scattered hairs, its tenuity being such as to permit the sub-cutaneous veins to be seen, as well as the contents of the sebaceous glands, which are very numerous in this situation; in the mesial line, rising from a depression on either side, is an elevation called the raphe, corresponding to the junction of the two tumid folds of skin, that marked in the fœtus the first or primitive condition of the rudimental scrotum; occasionally the junction is not completed, but a median fissure permanently separates the bag into two portions, simulating the labia of the female, each fold containing its respective testicle; and such has been the condition of many reputed hermaphrodites. The general relations of the scrotum are,—on each side, the thighs; below and behind, the perinæum; and above and before, the penis, from which it is suspended.

Dartos, is a thin layer of a yellowish white colour, with numerous reddish fibres interlacing through its structure; its figure represents a trapezium, or diamond; attached laterally, to the fascia covering the rami of the ischium, and pubis; anteriorly, to the corpus spongiosum urethræ; and posteriorly, to the central tendinous point of the perinæum; posteriorly and laterally, it sometimes extends backwards, partially covering the ischio-rectal space, and passing upwards in the middle line, it both assists in the formation of the septum scroti, and is prolonged forwards, so as to surround the penis. This tissue is lax, and in some cases strongly marked; the fibrous element most apparent in other instances, presenting here all the characters of ordinary areolar tissue, with a laminar arrangement.

Structure, is non-striated muscular fibre (Sharpey), or nucleated elastic tissue (Hassal); but the older anatomists conceived it to be

an expansion from the superficial sphincter ani, with which it undoubtedly is continuous at the middle tendinous point of the perinæum. By its contraction, corrugation of the scrotum is produced, and during sexual intercourse it exercises a sustained and equable pressure on the testicles to promote the elimination of the seminal secretion. The contraction of the dartos is seen, when cold is applied to the scrotum; and those circumstances which produce muscular asthenia in other parts of the body, have a similar influence on this tissue. As an instance, in advanced typhus, the scrotum is lax, and pendulous; but as the muscular tone returns, it again contracts to its ordinary shape and size; the same remark being equally applicable to all other debilitating influences.

Areolar Layer.—A prolongation of the superficial abdominal fascia is carried down on the cord, but loses in the scrotum its ordinary appearance, becoming lax, reticular, and totally devoid of the fatty character so evident on the abdomen; beneath the raphe, where it adheres intimately to the dartos, and skin, its density is somewhat increased. This tissue is very liable to become infiltrated with serum, as is evidenced in cases of erysipelas, and of orchitis, when it becomes enormously distended; but in consequence of the density of the areolar tissue beneath the raphe, the swelling may be confined to one side only, at least for some time, a similar condition being also observed in diffused areolar emphysema.

Scrotal Fascia, is a continuation of Scarpa's, from the abdomen; it passes downwards on the cord, and covers the scrotum, adhering to the rami of the ischium, and pubis on each side, and ascending in the mesial line, to form the septum, is attached to the urethra above; as it passes backwards, it increases in strength, and forms the perinæal fascia, which winds around the transversus perinæi to be attached to the base of the triangular ligament; and thus it is, that urine extravasated in the perinæum, reaches the scrotum, and abdomen. On this fascia, three superficial nerves are seen on each side,—the external long pudendal, a branch of the inferior sciatic, which ascends from the perinæum, and is continued as far forwards as the penis, and the long internal and external perinæal, branches of the pudic, which lie a little internal to the former, but have a similar destination. Many subcutaneous veins are likewise visible; they all run towards the root of the scrotum, and pour their contents into the vena magna integumentorum of the penis. The superficial arteries, are the terminal branches of the long perinæal, and the inferior superficial pudic of the femoral; but the principal branches of the latter, are distributed to the integument of the penis.

Tunica Communis, or Erythroidea, is formed of the expanded cremasteric fibres, placed between the internal, and external spout-

like fasciæ. In fœtal life, the cremaster consisted of two distinct portions, namely, the abdominal, and the scrotal, and these, in accordance with the views of Mr. Curling, have special fuuctions in relation to the desceut of the testicle. The muscle as a whole arises by one origiu, from the iliac half of Poupart's ligament, and by another from the spiue of the pubis, aud teudon of the rectus abdominis; the first or abdominal portion, ascends upwards and backwards to the testicle, including between its interual and external portious, the gubernaculum testis; while the second or scrotal passes downward, from the spine of the pubis, to be attached to the bottom of the scrotum. By the gradual contractiou of the abdominal portion, the gland is carried to the pubis, and during its descent the cremaster is involuted, so that the surface, which was internal in the abdomen, is exterual in the scrotum; haviug arrived at the pubis, the scrotal portion now takes up the contraction, and having carried the gland to its ultimate destination, it gradually becomes atrophied almost to perfect obliteratiou. The cremasteric fibres, though pale and weak in the infant, and in advanced life, present in the young aud robust a beautiful pink reticulated arrangemeut; and in a case of sarcocele which we lately examined, the fibres were collected iuto fasciculi, somewhat resembliug vessels emptied of their contents. By the inclusion of the expanded muscle, between the two spout-like fascia, the separation of its fibres when distended is prevented, and from the fact of its investing the cord, as well as surrouuding the testicle, it has received the name of "tunica communis." The exterual spermatic brauch of the ilio-scrotal nerve, lies on its anterior and external side, and divides into filaments for the supply of the scrotum, and cremaster; while small branches (cremasteric) of the epigastric artery, form the vascular supply.

Tunica Vaginalis.—Is in the adult, a distinct serous sac; but in the infant, communicates with the general peritonæal cavity. As the testicle lay in the iliac fossa, the peritonæum formed the immediate iuvestment for its anterior surface; but as the organ descends, it glides on the surface of the iliac fascia, still carrying with it that portiou of the serous layer, which adheres to the tunica albuginea. At Poupart's ligament, it reaches the posterior surface of the fascia transversalis, iu the site of the future iuternal abdominal ring, but by this movement the arrangement of the peritonæum is much altered; the growth of the abdomiual wall in an upward direction, draws the peritonæum with it; and that portion of the membrane carried downwards by the gland, instead of corresponding to the iliac fossa, is now the most iuferior part of the peritonæal sac, so that if the two serous membranes, be examined in an infant recently born, a perfect continuity, is seen to exist between their cavities

through a funnel-shaped aperture. There is no folding, or corrugation of the membrane, required to produce this change; but simply the development of the abdominal wall, with a coincident growth of the serous membrane, induces this alteration in the situation of its iliac division. Prior to the descent of the testicle, the internal ring is not formed; it is produced by the continued pressure of the testicle on the posterior aspect of the fascia transversalis, which is ultimately carried as a prolongation on its surface; thus the tunica vaginalis originally consisting of a single fold, is doubled by passing through the ring, forming the tunica vaginalis scroti which lines that bag completely, except for its two superior thirds posteriorly, and the tunica vaginalis testis which covers the gland, leaving a smooth, polished, and glistening cavity intervening between them. The external layer which adheres but slightly to the scrotum, should now be laid open, and when slit anteriorly and reflected, the testicle, epididymis, and vas deferens are seen. The tunica vaginalis adheres to the surface of the testicle most intimately, and is thence reflected on its sides as far back as the epididymis; but as it covers the outer side of the latter, it sends a process in between its body and the testis, forming a pouch in this situation, deep enough to admit the end of a scalpel handel, and covering the back of the testicle, and front of the epididymis. From the inside of the testicle, it is reflected on the vas deferens, which here intervenes, between it, and the epididymis; the former being very loosely attached to the tube; and tracing it still upwards, it passes as a distinct membrane, for about an inch on the cord, but somewhat higher internally, than externally. This tunic is transparent, and through its structure, the subjacent tunica albuginea, and the vessels of the gland are always visible; it is also stronger on the epididymis, in consequence of the deficiency of the tunica albuginea. Even on this part, however, we have always been able to detect a well-marked fibrous layer, that not only surrounds it, but also sends processes to invest the convolutions of which the epididymis is composed; this is always so remarkable on the globus major, and body, that we have been accustomed to describe it as the "fibrous capsule of the epididymis." This capsule is rendered even more distinct, in that form of enlargement of the epididymis, remaining after specific orchitis; as well as in cases of scrofulous disease, where it forms an investment for tubercular deposits. The object of the serous tunic appears to be, to facilitate the gliding motion of the testicle, thus assisting it to elude those concussions, to which its exposed condition renders it so liable.

The TUNICA VAGINALIS, is the seat of congenital hernia, when the canal connecting it with the abdomen is still pervious, and a portion

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of intestine may then escape and lie within its cavity; but should it occur subsequent to birth, when the canal is in the process of being obliterated at the internal ring by plastic lymph, and the intestine, as it escapes, carries the yielding exudation before it, as an expanded covering into the cavity of the tunic, it constitutes the "infantile hernia" of Hey. Within the tunica vaginalis, small cartilaginous bodies are frequently found, which are perfectly detached and free, but always in the vicinity of the epididymis, and these may be observed in cases where not a trace of any structural change can be detected in the gland itself.

The TESTICLES are normally two in number, but as before stated, one may be retained in the abdomen, canal, or ring. Instances are likewise mentioned, of these organs exceeding the natural number; but, it should be remembered, that any cases merely examined through the coverings of the scrotum, are scarcely worthy of credit, as many circumstances conduce to favour mistakes, such as a portion of omentum in the vaginal tunic; and scrofulous, or hydatid tumours in the gland. In a subject dissected last session, prior to opening the sac, there was every reason to suspect a supernumerary organ, but it proved to be a very interesting anomaly, for the epididymis was placed on the front of the testicle, the anterior edge of which, was directed backwards. Each testicle, is ovoid in figure, a little larger below than above, and placed obliquely in the scrotum, so as to diverge superiorly and converge inferiorly, with the posterior edge looking upwards and backwards, and the anterior downwards and forwards; its vertical measurement is, from one and a half to two inches, its antero-posterior from one inch to one and a half, and its transverse from three-quarters to an inch; but these probably are all a little in excess. The left testicle, is always on a plane much inferior to the right, and Sir A. Cooper believes that this position facilitates their gliding movements in eluding pressure, and allows the penis to project towards the left side, instead of directly forwards; it is also accounted for by the left spermatic vein opening into the renal, at a right angle, so that a resistance is afforded to the ascent of the venous blood from the left testicle, and thus it is gradually lowered in its position; but the real cause must be sought, in the situation it occupied in fœtal life, for during that period, the right testicle lies in the abdomen much lower than the left, owing to the liver depressing the right kidney; and thus the cremaster, and gubernaculum testis, as well as the vas deferens, which at that period runs to the base of the bladder directly, must be shorter on the right side; and hence it follows, as a result that might be anticipated, that when the testicles descend, the shorter cremaster, and vas deferens prevent the organ on the right side extending so

low down as that on the left, which has a much longer cremaster, and duct, as it previously lay much higher in the abdomen.

Tunica Albuginea, or Propria.—Individually a fibrous, but in connexion with the tunica vaginalis, a fibro-serous membrane, covers and adheres to the surface of the testicle, and at the posterior edge dips into the gland, between it and the epididymis, to form a cavity, called the mediastinum testis, or corpus Highmorianum. To fully appreciate this arrangement, a transverse section should be made of the gland, and it will then be seen that the mediastinum is triangular in shape, with the apex directed towards the anterior edge, and the sides formed by the inverted portion of the fibrous tunic. From the apex, a number of sepimenta, or trabeculæ, radiate forwards to the internal surface of the tunic, separating the testis into a series of loculi, or lobules, each forming a distinct compartment. The tunica albuginea, is of a bluish white colour, resembling the dura mater, being equally dense in structure, but thinner and more transparent; the unyielding nature of this membrane explains the absence of any great amount of swelling of the gland itself in orchitis, but still it will always gradually yield to long-continued distention, as in sarcocele. The existence of the sepimenta also accounts for the fact, that the contents of one loculus only may escape, as in lipoma, or scrofulous sarcocele, and that the disease may then terminate, without entailing the loss of the entire organ.

Structure of the Testicle.—By raising off the tunica albuginea, on one side of the gland, there will be seen adhering to its deep surface a vascular membrane, known as the tunica vasculosa, or pia mater testis; it surrounds the glandular structure, and sends a process on each lobule, enclosing it like a sheath of pia mater, to which it is analogous in structure, being areolo-vascular. The serous membrane may now be removed from the epididymis, and a few of the superficial lobules scraped off, when the further examination of the gland should be pursued under water.

The testicle, consists of a system of tubules commencing rarely by free extremities, but more frequently by loops, or anastomosing branches; each tubule is from $\frac{1}{170}$ to $\frac{1}{195}$ of an inch in diameter, two or more being enclosed in each lobule, of which there are four hundred and twenty in each gland, thus making the tubes to amount to eight hundred and forty altogether. According to the measurements of Lauth, each tube is two feet three inches in length, but the estimate of Monro far exceeds this, as he lays them down at sixteen feet each, the whole taken together amounting to over five thousand feet. The base of each lobule is directed towards the anterior edge of the testicle, and the apex towards the mediastinum; from the latter the tubuli recti, about twenty in number, and $\frac{1}{95}$ of an inch in diameter, converge,

and entering between the layers of the mediastinum testis, form the rete testis, consisting of a number of wavy tubes, from seven to thirteen in number, which frequently divide, and anastomose in their course to the upper part of the mediastinum, where they terminate as the vasa efferentia, or coni vasculosi, which constitute the emissory tubes, and are collected into a narrow fasciculus, composed of about thirteen canals, somewhat smaller than the tubuli recti, which join the globus major of the epididymis.

Epididymis.—Hourglass in shape, and placed at the superior and posterior part of the gland, consists of a head or globus major, body, and tail or globus minor; it is formed of a single tube, about twenty-one feet in length (Lauth), convoluted with the greatest intricacy, and arranged in spheroids or lobules, having a free communication with each other, in this respect differing from the lobules of the testicle, which do not communicate; the lobules are united by a fibrous layer or envelope, already described, which preserves their natural relation to each other, but they all terminate in the globus minor, from which the vas deferens, as well as the vasculum aberrans, arises. The attachment of the epididymis to the testicle, is tubular, vascular, and membranous, the globus major being attached by the vasa efferentia, the globus minor by the branches of the spermatic artery, and the body, as well as the two globi, by the tunica vaginalis.

Vas Deferens.—This tube is a continuation of the epididymis, from which it arises at an acute angle, and is at first a little contorted; it ascends on the internal side of the epididymis, to which it is closely connected, and at the globus major is joined by the spermatic artery, and vein, behind both of which it lies; continuing its course over the pubis, it passes through the external ring, and proceeding outwards and upwards through the inguinal canal, enters the internal ring, then crosses the external iliac artery, vein, and genito-crural nerve, iliacus, and psoas muscles, and winds round the outer side of the epigastric artery, separated from it, however, by one of the venæ comites, but as it crosses the descending portion of the epigastric, it is separated from it by the spermatic artery,—the order of superposition in this situation being, vas deferens, spermatic artery, epigastric artery, and lastly, external iliac vein; it then passes downwards, backwards, and inwards, inclosed in the lateral false ligament of the bladder, and on the side of that viscus, crosses external to the obliterated hypogastric artery; as it still continues its course backwards, it passes next internal to the ureter, and then altering its direction, turns downwards, forwards, and inwards to reach the prostate, just at this point lying in front of the terminal portion of the internal iliac artery; on arriving at the internal side of the vesiculæ seminales, its figure undergoes a

striking change; for while above, it was rounded in form, at the base of the bladder it becomes flattened, and involved in the same fibrous capsule as the seminal vesicle; reaching now the base of the prostate and receiving the duct of the seminal reservoir, it assumes the name of ductus communis ejaculatorius, and losing its proper tunic, pierces the base of the prostate gland, through a notch for its reception, being here smaller than the combined diameters of the ducts that formed it; ultimately it passes obliquely upwards and forwards, below the middle or Home's lobe, and piercing the mucous membrane of the floor of the prostatic portion of the urethra, opens at one side of the verumontanum in the prostatic sinus.

Structure of the Seminiferous Tubules.—Each tubule of the gland is highly elastic, and consists of a cylinder of nucleated elastic tissue (Hassal), these nuclei being most visible in the immature testis; and the secreting surface, which is general throughout the entire length of the tubes, being lined by a layer of cells, constituting the epithelium. Some of those cells contain but a single nucleus, and others, three or four; but all have this common character, that they possess a remarkable tendency to be thrown off from the surface on which they are developed. It is in these cells that the formation of the spermatozoa occurs. The anatomy of the epididymis, is similar, but the tunics are thicker. The vas deferens, consists of a dense external fibrous coat, which Lewenhoeck believed was muscular, and which it certainly is in the horse—the canal being exceedingly small, merely capable of admitting a bristle, but it is somewhat larger at the base of the bladder. When laid open, the surface is seen covered by a fine mucous membrane, but still irregular in its character, in consequence of a layer of whitish fibres, that lie external to the mucous membrane, and cross each other at acute angles. The spermatic cord consists of the spermatic vessels, lymphatics, spermatic plexus of nerves, genito-crural nerve, cremasteric, and deferential arteries, surrounded by the degenerated tubule of serous membranes, internal spoutlike fascia, cremaster, and external spoutlike fascia. The vessels, and all the other structures alluded to, will be found described in their proper place, or system.

Development of the Testicle.—Those organs make their appearance in the lower and inner part of the Wolffian bodies, at the close of the seventh week, and at first consist of a granular albuminous fluid, which serves as the nidus in which the tubuli seminiferi become developed. But the epididymis, does not appear until about the tenth week, and the gubernaculum at the thirteenth. The testicle commences its descent, from the seat of its development, about the fifth month of intra-uterine life.

The function of the testicle is, to secrete the seminal fluid, which is compound in its nature, consisting of a fluid portion, or liquor seminis, and certain solid constituents, namely, the spermatozoa, mucous corpuscles, seminal granules, and epithelium. The most important of these, are the first, or the spermatozoa, each of which consists of a disc or head, and tail, and is endued with distinct automatic movements, which are evident for some time after the ejaculation of the fluid; they are developed within cells from nuclei, and are then set free, precisely as the young of the volvox, but whilst they cannot be detected until the period of puberty, they are always present until an advanced stage of life.

Having completed the dissection of the generative organs, the student should now prepare the subject for the purpose of examining the perinæal region; for this purpose, the nates should be brought to the edge of the table, or be supported on a block in that position, if the table is low; the thighs should also be flexed on the pelvis, and the legs on the thighs; while the wrists, placed in contact with the external malleoli, should be secured to them, by means of a bandage, or cord; some hair or tow should be introduced into the rectum, and a staff passed into the bladder—the staff being retained in position, by a ligature placed round the corona glandis.

The Ano-perinæal Region, of an oval or diamond shape, is bounded anteriorly, by the pubis and subpubic ligament; laterally, by the descending ramus of the pubis, ascending ramus, and tuberosity of the ischium, and great sacro-sciatic ligament; and posteriorly, by the coccyx; but in the subject, where all the parts are still untouched, and hold their proper relative position to each other, the boundaries are somewhat different, as it is limited in front, by the scrotum; behind, by the coccyx; and on each side, by the thighs. When we proceed to examine the superficial surface of this region, we will find the skin to be fine anteriorly; but posteriorly, where it merges with the integument of the buttocks and thighs, it becomes much stronger and denser; again, at the verge of the anus, it is thin and rugated, with the folds converging towards the orifice, and in the intervals between them excoriations frequently occur, attended with most distressing symptoms, consequent on the action of the sphincter. The surface markings in this region are few, but important,—in the middle may be observed, extending from the anus to the scrotum, a conical elevation, with the base at the anus, and the truncated apex gradually disappearing in the root of the scrotum; and while a raphe occupies its middle line, on either side a concavity occurs, corresponding to the rami of the ischium, and pubis; the mesial conical elevation, indicates the position of the urethra—a fact of

great surgical importance in certain surgical affections. The integument in this region, like that of the scrotum, is of a darker colour than in the other parts of the body, and it is also studded with hairs, varying in number, according to the subject that may be examined. The entire space, is generally divided by a line drawn between the prominent points of the tuberosities of the ischia, thus isolating two distinct tracts; known as the anterior true, or urethral perinæum, and the posterior false, or anal perinæum ; the anterior containing the urethra, and the crura penis, with their subsidiary muscles ; and the posterior, the anus, and its sphincters. The anterior region, by far the most important, measures from base to apex in the raphe three inches ; at the sides three and a half ; and across the base three. By now making a cautious incision from the scrotum to the anus, and a second backwards to the coccyx, with a transverse one from that orifice to the tubera ischii, and uniting them by a circular cut around the anal orifice, the four flaps may be reflected outwards, and the subcutaneous layer, superficial sphincters, and subcutaneous nerves, and vessels may be examined. The subcutaneous layer continuous above with the superficial fascia of the scrotum ; laterally with that of the thighs, and posteriorly merged in the fatty areolar tissue of the ischio-rectal fossæ, is extremely fatty in the child, and at the advanced periods of life, but in the adult is dense, and frequently exhibits aponeurotic fasciculi, which however, gradually disappears as the fat predominates. When this fascia is cautiously raised, a second, which should be named *proper perinæal fascia*, is brought into view, dense in its character, of a bluish white colour, stronger than the superficial, but yet semitransparent, attached laterally to the rami of the ischium, and pubis, continuous above and before, with Scarpa's fascia on the scrotum, and posteriorly bending upwards, behind the transverse perinæi muscles, to become united with the anterior edge of the base of the triangular ligament ; from its deep surface two longitudinal septa pass upwards to be attached to the perinæal face of the triangular ligament, thus dividing the anterior perinæum into three distinct compartments ; the mesial containing the urethra, and acceleratores urinæ ; and the lateral, inclosing the crura, and erectores penis. In consequence of these attachments, it is evident, that urine extravasated in the perinæum cannot become diffused, either laterally or posteriorly, but must follow the course of Scarpa's fascia, upwards on the scrotum, and thence be conducted by the cord to the abdomen ; while the vertical septa confine it to the mesial space, prevent its contact with the crura, and produce that funnel-shaped tumour so indicative of this accident. On raising this fascia the superficial vessels, and nerves, which really lie between its layers, are exposed : the vessels consist

of the transverse perinæal artery, a branch of the internal pudic, but sometimes derived from the long perineal; it winds round, from behind the transverse perinæi muscle to its cutaneous surface, and running inwards, divides into anterior, posterior, and communicating branches: the first, passing forwards, to the accelerator urinæ, and bulb; the second, backwards, to the verge of the anus, to anastomose with the anterior external hæmorrhoidal; and the communicating, directly inwards, to unite with a similar branch of the opposite side. The long perinæal, also a branch of the internal pudic, pierces the base of the triangular ligament, winds round the transversus perinæi, external to the transverse artery, runs upwards, forwards, and inwards, on the outer side of the accelerator urinæ, and arriving at the scrotum, divides into an external, and internal branch; the former, ramifies on the inferior and external surface of the scrotum, communicating with the inferior external pudic; while the latter, known as the arteria septi scroti, is distributed to the septum, and when cut, sometimes causes troublesome hemorrhage, as in castration.

The superficial nerves, are the long perinæal, and consist of the internal, and external; they are branches of the pudic, and pursue a course similar to that of the artery of the same name, on each side of which they severally lie; the long pudendal, or perinæo-scrotal, a branch of the lesser sciatic, is also found in the layers of the superficial fascia, and after winding round the ascending ramus of the ischium, about half-an-inch above the tuber, runs upwards, forwards, and inwards, obliquely over the perinæum, to terminate in the scrotum, and penis.

Muscles of the True Perinæum, are three pair—namely, transversus perinæi, erector penis, and accelerator urinæ.

Transversus Perinæi.—Triangular in shape, and fleshy, lying at the posterior edge of the space; arises by a flat tendon from the internal side of the tuber ischii, above and behind the erector penis; it soon becomes fleshy, and passing obliquely forwards and inwards, is inserted into the central tendinous point of the perinæum, in front of the verge of the anus, and behind the bulb of the urethra.

Relations.—This muscle receives frequently a slip from the superficial sphincter, and not uncommonly, passes completely over the central point to meet its fellow, thus forming a distinct muscular plane, or arch in front of the anus. From the point of insertion, a fleshy slip passes forwards and upwards, on the side of the accelerator urinæ, and this is so often present, that it would almost seem to be the normal arrangement; sometimes, however, it may have a distinct origin from the ascending ramus of the ischium, and under those circumstances it is named transversalis alter, the long perinæal artery,

in this case, separating the two portions. The transversus perinæi is covered by the transversalis artery, integuments, and fascia, and lies on the base of the triangular ligament, which separates it from the levator ani; posteriorly, it corresponds to the dipping in of the fascia, the long, and transverse perinæal arteries, and superficial sphincter; and anteriorly, to the accelerator urinæ, and a triangular space, which contains the long perinæal artery, and nerve.

Action.—To fix the central point for the attachment of the other muscles, viz.—the sphincter, and levator ani, and accelerator urinæ, and to draw the bulb downwards and backwards.

Erector Penis, or Ischio-cavernosus.—An elongated muscular and aponeurotic fasciculus, lying on the crus penis; arises by short aponeurotic fibres, that immediately become fleshy, from the inner edge of the tuber ischii, below and in front of the transversus perinæi; it passes upwards, forwards, and inwards, and is inserted by an aponeurotic band, that commences on the surface of the muscle, into the corpus cavernosum penis. This band placed between a separation of the muscular fasciculi, the external portion of which is often prolonged for some distance on the crus, is directed obliquely outwards and forwards.

Relations.—It is covered by the fascia, skin, and dartos, and lies upon the crus penis, and transversus perinæi; internally, it corresponds to the ischio-urethral space, which, with the long perinæal artery, separates it from the accelerator urinæ muscle.

Action.—To draw the penis downwards and backwards during erection; and this action, apparently rhythmical, would seem to dilate, rather than compress the crus. It is a fallacy to suppose, that these muscles can produce distention of the penis, by compressing the veins of the crura, as there exist several objections to such a view. In the first place, the mechanical arrangement is the opposite to that which would cause compression; secondly, the contractions are not permanent during erection, but rhythmical; and lastly, the venous blood has many other subsidiary modes of escape from the crura, as will be described with the anatomy of the Penis. The true explanation of its presence in this situation, would appear to be, that it is nothing more than the analogue of the muscular origin of this organ as found to exist in some of the lower animals, of the same class as man.

Accelerator Urinæ, or Bulbo-cavernosus.—Bipenniform in arrangement and lying on the spongy portion, and bulb of the urethra, arises from the central tendinous point of the perinæum, and the median tendinous raphe which separates the two muscles; the fibres pass upwards, forwards, and outwards; the most posterior, short and thick, are inserted into the perinæal face of the triangular liga-

ment, often extending outwards to the bone; the middle, bend upwards so as to encircle the urethra, and are attached to a shining aponeurotic band in that situation; while the anterior, the longest, are directed upwards, forwards, and outwards, and are inserted into the surface of the fibrous tube of the corpus cavernosum penis.

Relations.—It lies on the corpus spongiosum, and bulb of the urethra, from which it is separated by a tubule of the triangular ligament; and on the triangular ligament, and crus penis; and it is covered posteriorly, by a slip of the transversus perinæi, by the erector penis, and deep fascia, with a tubule of which it is invested; while on either side, it corresponds to the erector, long perinæal artery, and nerve. Where this muscle is attached to the crus, it sometimes bends over its surface to the dorsum of the penis, and the muscular fibres thus appearing in this position, are considered by many anatomists to represent the muscles of Houston, as described in the Dublin Hospital Reports; but these will be referred to in the anatomy of the PENIS.

Action.—To compress the urethra, and sustain a gradual pressure on that canal, during its distention by the column of urine; also, to expel the last drops of urine, or seminal fluid, that remain in the bulb, and this is accomplished by momentary, but energetic contractions, which cause their expulsion, by jerks rather than by sustained efforts. This muscle, from the peculiar manner in which it is inserted behind the bulb, may be engaged in spasmodic stricture; and is perhaps more frequently the seat of this disease, than Wilson's, or Guthrie's muscles. They can often be felt like a cylinder of wood beneath the skin, when an instrument is being introduced into an irritable urethra.

Between the muscles just described, a triangular space exists, with its base behind, and apex in front, called the ischio-bulbar, or ischio-urethral, bounded externally by the erector, and crus penis, internally by the accelerator urinæ, and behind by the transversus perinæi. If an effort be now made, to press the fingers upwards, through this space into the pelvis, it will be seen that the triangular ligament forms the roof or superior boundary; and it is through this triangular interval, that the knife must pass in the lateral operation of lithotomy, in order to reach the membranous portion of the urethra. We have observed considerable variations in its appearance, as for instance, the accelerator, and erector penis, may be united on its surface; or the bulb may be of such a size, particularly in the old, as to overlap the space, concealing it altogether, or the transversalis perinæi may be so oblique, or continued so far upwards and inwards in connexion with the accelerator, that the space may be altogether absent. The long perinæal artery, and nerve, run through it in their course to the scrotum, but are rarely injured by the knife of the

operator, as they are parallel to the line of incision required for lithotomy. In this stage, also, attention should be directed to the recto-bulbar space, as it is of very great importance, in the perinæal section, for retention of urine. It lies, as its name implies, between the rectum and bulb,—the one bounding it posteriorly, and the other anteriorly; while above, is the membranous portion of the urethra; and on either side, Cowper's glands, and the arteries of the bulb. This space measures about an inch, from the surface of the perinæum to the membranous portion of the urethra; and about three quarters of an inch, from bulb to anus.

The posterior region, which presents for dissection in the present stage two muscles,—namely, superficial, and deep sphincters, and the ischio-rectal fossæ, with their contents, may now be examined.

Sphincter Ani Externus.—A flat, oval plane of muscular fibre, interrupted in the centre by an elliptical aperture, with one surface directed upwards, the other downwards; not subcutaneous however, as it is usually termed, but separated from the skin, by a thin layer of fascia. It arises by a thick, strong tendon (ano-coccygeal ligament) from the last bone of the coccyx, and passing forwards reaches the posterior edge of the anus, where it divides into two fasciculi, which surround it, and again uniting at its anterior margin, are inserted into the raphe, superficial fascia, and central tendinous point of the perinæum, where they become continuous with the dartoid tissue of the scrotum.

Relations.—It is covered by the skin and a thin layer of fascia, and rests on the levator ani, and the fat of the ischio-rectal fossæ; while internally it corresponds to the annular fibres of the rectum, which are easily recognised by their paleness. The inferior hemorrhoidal arteries, and veins, terminate in the outer border.

Action.—The external fibres can contract the rectum, while the internal act only on the anus. This muscle is peculiar in being contracted in its quiescent state, the stimulus to that condition being the pressure from above.

Internal Sphincter, consists of a pale fasciculus of muscular fibres, surrounding the extremity of the rectum for about an inch in depth; attached anteriorly to the central tendinous point of the perinæum, and posteriorly, to the ano-coccygeal ligament, by a loop of areolar tissue. It lies above and internal to the superficial sphincter, and appears to be merely a thickened portion of the annular fibres of the rectum. Its use is similar to that of the external sphincter; and both appertain to the mixed class of muscles.

The fat, and areolar tissue, should now be carefully removed on each side of the rectum, and a deep cavity, the ischio-rectal fossa, will be exposed, of a triangular shape, with the apex above, and the

base inferiorly; it is bounded externally, by the obturator fascia, obturator internus muscle, and tuber ischii; internally, by the rectum, and levator ani; anteriorly, by the transversus perinæi, and posterior layer of the triangular ligament; and posteriorly, by the great sacro-sciatic ligament, overlapped by the glutæus maximus. The base is formed by the integument, and fascia; and the apex, at the origin of the levator ani, presents a dense, curved line, at the point where the obturator fascia from the outside, and the anal or ischio-rectal from the inside, unite. This space measures from side to side one inch, and in the antero-posterior direction, as well as in depth, about two; it contains a quantity of fat, the external hæmorrhoidal vessels and nerves, and in the outer wall lies the pudic artery, only separated from the space, by a thin layer of the obturator fascia. The object of the space is, to allow of distention of the rectum, and to permit that facility of movement for which it is so remarkable. Under particular circumstances, the large quantity of fat, together with its low organization, predisposes to the extensive diffusion of matter, and the mobility of one wall of the abscess, when once fully formed, with the unyielding nature of the other, as certainly favours the formation of fistula.

External Hæmorrhoidal Arteries, are two in number on each side, arising from the internal pudic, as it lies in the triangular space internal to the tuber ischii; they pierce the obturator fascia, the anterior sending branches forwards to the tranversus perinæi, and then reaching the rectum, they form a circle of anastomosing branches on its surface. The veins which accompany those arteries, terminate in the pudic; and the nerves, are also branches of the pudic trunk.

By now removing the erector penis, accelerator urinæ, and the transversus perinæi, with the long perinæal artery, and the crus penis of one side, the triangular ligament will be exposed.

Triangular Ligament, shaped as its name implies, occupies the space between the diverging rami of the ischium, and pubis, and is about one inch and three quarters in length; its sides are attached to the rami of the pubis, and ischium, extending down as far as the tuberosities of the latter bone; and the apex, which corresponds superiorly, to the subpubic ligament, divides into two layers, of which one passes upwards on the posterior surface of the symphysis to become continuous with the lower edge of the anterior true ligaments of the bladder, and the other is prolonged on the dorsal veins of the penis; the base, strictly speaking, is badly defined, but when dissected carefully, is double lunated, exhibiting an arch on each side of the middle line, the mesial slip being attached to the central tendinous point of the perinæum; and the two lateral, to the tuberosities of the ischium, where they become continuous with the obtu-

rator fascia, and falciform process of the great sciatic ligament; the anterior margin of the base, gives attachment to the proper perinæal fascia; while the posterior, passes backwards on the perinæal aspect of the levator ani, and is there continuous with a thin expansion from the obturator fascia; some bands being also prolonged into the ischio-rectal fossæ, to separate and support the fatty tissue in that region. One inch below the symphysis pubis, the triangular ligament is pierced for the exit of the membranous portion of the urethra, and as it passes through it, a process from the posterior surface is prolonged backwards, on the intrapelvic portion of the membranous division, and continued backwards on the under surface of the prostate gland, to form a part of its capsule, afterwards becoming incorporated with the recto-vesical fascia of Tyrrell; from the anterior surface, another process passes forwards, on the bulb, and spongy portion of the urethra, giving to the canal that smooth and glistening aspect, which it presents when the accelerator urinæ is removed. But in addition to the urethral opening alluded to, there are also three arterial perforations on each side, which from without inwards, lie in the following order:—one for the internal pudic artery; another for the long perinæal; and a third for the transverse perinæi. A tubular opening also exists at the apex, for the dorsal vein of the penis; and on either side of it, smaller ones for the dorsal nerves which are branches of the pudic. The anterior surface of the triangular ligament, is covered by the crura, and erectores penis, transversalis perinæi, and acceleratores urinæ muscles, the long perinæal artery, and nerve, and the bulb, and spongy structure of the urethra, which lie on it for about an inch and a quarter; while the posterior, corresponds to the anterior face of the bladder, prostate gland, membranous portion of the urethra, levatores ani, curve of the rectum, and dorsal nerve of the penis.

In the general outline which we have given above, we have considered the ligament as single, but it actually consists of two layers perfectly distinct from each other; called the anterior, and posterior; when the former is removed, the following parts will be observed to lie between them:—1. Cowper's ante-prostatic glands; 2. Wilson's, and Guthrie's muscles; 3. Pudic artery; 4. Artery of the bulb; 5. Membranous portion of the urethra.

Cowper's Glands.—Two small ovoid tubular bodies, lying on either side, and below the membranous portion of the urethra; they are surrounded by a dense saccule reflected from the triangular ligament, and are very variable in size, being sometimes as small as an ordinary pea, or again, as large as a kidney-bean. From the superior part, a duct emerges, that passes upwards and forwards for about an inch, grooving the bulb, and then opens obliquely, into the spongy

portion of the urethra. These glands consist of a single duct, to which the secondary tubes are attached, the latter being of the same diameter throughout, and presenting a long, slender, looped, or convoluted appearance; but they are never arborescent, or minutely divided in their character.

Relations.—Anteriorly, and posteriorly, they correspond to the triangular ligament; below to the transverse perinæal muscle; and above, to the artery of the bulb, from which their vascular supply is derived; they secrete a fluid, which is probably mixed with the seminal secretion, during its discharge, but the variations in their magnitude, seems to imply, that their function is unimportant.

WILSON'S MUSCLES.—Are two bands, that arise from the lower edge of the symphysis pubis, and terminating in tendons that surround the urethra, are inserted into the central tendinous point of the perinæum. Mr. Guthrie believes, that the existence of such muscular bands is unusual, and considers the actual arrangement to be the following—he states that a half-circle of tendon exists above, and a similar one, below the membranous portion of the urethra, and from the sides of the circle thus formed arises a muscular band on each side, sometimes bifid, which passing outwards, is inserted into the ramus of the ischium, where it joins the pubis. We have seen Wilson's muscles frequently, and always found them to vary considerably in size; the same remark is equally applicable to those of Guthrie; but the student should at the same time bear in mind, that instances will occur, and more repeatedly than he would be led to expect from books, where not a vestige of muscular structure can be detected, no matter how carefully the dissection may be conducted. It is strange that Mr. Harrison should look upon these structures, when they do exist, as being a part of the anterior fibres of the levator ani, and that he should have overlooked the fact, that they are separated from that muscle, by the posterior layer of the triangular ligament; for in all the cases that we have examined, the separation between them, was sufficiently obvious, to allow distinct demonstration. That it is possible, by special intention, to produce appearances similar to those figured in recent works, as being the natural arrangement of the urethral compressors, is evident; but if merely the anterior layer of the ligament, and no more, is removed, and all derangement by the use of hooks dispensed with, it will be seen that what we have stated above, is strictly correct in almost every case; that the presence of those muscles never can be depended upon; and even if present, their arrangement is so arbitrary that it is utterly impossible, consistently with truth to assign any fixed point to which they would be found constantly attached. It is only fair to add, that they were first described by Santorini.

Use.—To compress the urethra, or by tonic contraction induce spasmodic stricture, and consequent retention of urine.

For the description of the internal pudic artery, vein, and nerve, with the branches given off by each in this region, we must refer the student to the sections devoted to their consideration. In order to examine the levator ani, the posterior layer of the triangular ligament should be removed, the rectum drawn downwards and backwards, the thin layer of fascia which covers and adheres to the perinæal surface of the muscle should be dissected off, and when a lateral section of the pelvis is made hereafter, its pelvic aspect can be more fully examined.

Levator Ani, a flat, thin, fleshy expansion of muscular fibre, deeper behind than before, occupying the inferior outlet of the pelvic cavity; arises from the posterior surface of the symphysis pubis, inferior and external to the anterior true ligaments of the bladder; and from an arched tendinous band formed by the splitting of the pelvic fascia, extending from the pubis to the spine of the ischium, as well as from that bony point itself; the fibres are divided into four portions,—namely, prostatic, anal, præcoccygeal, and coccygeal; of these, the first form a flat band, the anterior fibres of which are inserted into the dorsum of the prostatic capsule, while the posterior, which are longer, pass round the gland, and are attached into the central tendinous point of the perinæum; the anal fibres, are divisible into an anterior, and posterior set, the former passing downwards and inwards, separated from the side and inferior fundus of the bladder by the recto-vasical fascia; and the posterior, downwards and backwards, inferior and posterior to the rectum; both sets ultimately encircling the intestine, and becoming united with the internal sphincter, from which the fibres cannot be distinguished; the præcoccygeal portion passes downwards and inwards, and is inserted into the ano-coccygeal ligament; and, finally, the coccygeal fibres run backwards and inwards, to be attached to the side, and forepart of the coccyx.

Relations and Structural Anatomy.—There is extreme variability in the thickness and density of this muscle, in different subjects,—as in some, it is weak and thin, with wide intervals separating its fasciculi; while in others, it is strong and red; but the division into bands of unequal widths, is a character always present, which renders its structure not unlike that of the diaphragm; the prostatic fibres are weak, as well as the coccygeal; but the anal, and the præcoccygeal, are much stronger; and it is not infrequent, to find the prostatic exhibiting a number of separate bands, wholly unconnected with the anal fibres. In the male, there are two openings in this muscular plane; one which is somewhat elliptical in shape, but wider below

than above, with edges well defined and abrupt, permitting the passage of the apex of the prostate; the other, more posteriorly, on a plane inferior to the last, and funnel-shaped, prolonged on the rectum, and impossible to define; its circular orifice allowing the rectum to pass to the anus. The superior edge of the muscle is crescentic, with the concavity looking upwards and backwards; and here the pelvic fascia splitting into an internal or vesical, and an external or obturator layer, through this medium only, the levator ani is attached to the brim of the pelvis, but it is incorrect to say that the muscle itself is connected to the bone. By its pelvic surface, it corresponds to the anterior true ligaments of the bladder, and prostate gland, to the vesical fascia, and recto-vesical layer, which separates it from the inferior fundus of the bladder, to the vesiculæ seminales, vasa deferentia, rectum, and a quantity of lax areolar tissue; and by its perinæal, to the triangular ligament, superficial sphincter, the reflected base of the triangular ligament, the fat which occupies the ischio-rectal fossa, and the external hæmorrhoidal arteries, and veins; while the coccygeal fibres have, to their posterior and external surface, the coccygeus muscle. A special branch of the sacral plexus supplies each muscle, the arteries being derived from the hæmorrhoidal and sacral.

Action.—To fill up the outlet of the pelvis, to support its contents, to assist in closing the rectum, and afterwards in elevating it, after it has been depressed by the action of the abdominal muscles in defæcation; also to constrict, and raise the vaginal orifice, which it surrounds in the female; to raise the prostate, and compress it during micturition, and to force the seminal secretion into the bulb of the urethra.

Coccygæus, or Ischio-coccygæus, external and posterior to the levator ani, arises tendinous from the internal surface of the spine of the ischium; and, passing backwards and inwards, is inserted broad and tendinous into the side of the coccyx, and extremity of the sacrum.

Relations.—It corresponds, by its internal and anterior surface, to the levator ani; and externally and posteriorly, to the lesser sacro-sciatic ligament.

Action.—To draw the coccyx forwards and downwards, and thus preserve the position of the rectum, uterus, and vagina.

Penis.—This organ, in its collapsed condition, is cylindrical; but when distended, prismatic; the margins being formed, below by the urethra, and on each side and above by the crura. Although the principal bulk of the organ is formed by the crura, corpora cavernosa, and corpus spongiosum urethræ, there are also several superficial investments, which require individual description; these we will pro-

ceed to examine in the order in which they present themselves, from superficial to deep.

Integument.—Fine and delicate, of a brownish colour, especially on the inferior surface, and very moveable ; tracing this investment forwards to the corona glandis, it becomes free, and forms the prepuce, by a replication or folding on itself ; but, at the corona, it adheres very intimately to the subjacent structures, on account of its prolongations into a series of follicles (glandulæ Tysoni, or odoriferæ), which surround it and secrete a viscid semifluid matter, the precise use of which is not well understood ; while beneath the glans, it forms a fold continuous posteriorly with the prepuce, and in front with the inferior angle of the urethral orifice, known as "frænum-præputiale," its use appearing to be, to connect the prepuce with the glans penis during erection of the organ ; and also to curve the orifice of the urethra downwards, in order to direct the seminal fluid backwards, towards the os uteri. On the glans itself, the skin exhibits the appearance of a mucous membrane, and really does become directly continuous with it a little within the urethral orifice, but still on the part alluded to, it is nothing more than the integumentary covering, greatly modified, no doubt, as shown by its more exalted sensibility, and increased vascularity.

Dartos, lies directly beneath the skin, and is similar to that of the scrotum, with which it is continuous below, but it is finer, paler, and more lax in its character, and completely invests the entire organ.

Superficial Fascia, is abundant in all parts of the organ, and particularly so between the layers of the prepuce, its extreme laxity accounting for the facility with which serous infiltration may here occur; but at the corona glandis, and on the glans, and frænum, it is much more dense ; and in the latter situation its character is distinctly fibrous, the fibrillæ being of unequal diameters, and often twisted into coils, with the yellow fibrous element predominating. This tissue is however thick, and often lamellated, at the root of the penis, where it is continued from the pubis, as its false suspensory ligament ; but more anteriorly, it ceases to form laminæ, and becomes weak and reticular, but never adipose, as on the abdomen. Immediately beneath the superficial, a deeper layer is found, derived from Scarpa's fascia, thin, but strong and aponeurotic in its texture, investing the whole organ, but not extending beyond the corona, nor do any of its fibres appear to pass into the prepuce. In connection with those fasciæ, the following parts may be seen :—superiorly, the dorsal cutaneous veins and arteries ; laterally, cutaneous branches of the dorsal nerve ; and inferiorly, the long perinæal, and pudendal nerves, each of which will be found described under their proper systems.

True Suspensory Ligament.—This fibrous layer, strong, dense,

and triangular in shape, is attached posteriorly to the symphysis pubis, where it is continuous with the decussating fibres of the external oblique tendon; anteriorly, and superiorly, it is free and round; while inferiorly, and posteriorly, it divides and expands, to invest the organ with a dense unyielding covering, which on the dorsum splits to enclose the dorsal vein, artery, and nerve between its layers.

Occasionally there may exist in this situation, as described by the late Dr. Houston, a thin flat band of muscular fibre, which arising from the rami of the pubis, and ischium, and passing upwards and inwards, unites in a common tendon with its fellow, over the dorsal vein of the penis, so as to compress it; but, although this arrangement is constant in the lower animals, such is not the case in the human subject, as in forty-five subjects carefully examined its existence could only once, be fairly demonstrated. The deep fibres of the suspensory ligament, with attachments similar to those of the above muscles, are often confounded with them; but while the former are of the same structure in their entire course, the latter are three-fourths fleshy, and the remainder tendinous; and are separated from the forked fibres of the accelerator urinæ, where they turn over the dorsum of the penis, by the expansion of the suspensory ligament.

Use of Houston's muscle, or compressor vinæ dorsalis, if admitted to exist.—To compress the dorsal vein of the penis, and prevent the return of venous blood, thus causing erection of the organ.

When the expansion of the true suspensory ligament has been cautiously removed, from the dorsum of the penis, a superficial longitudinal groove will be observed, extending from a little anterior to the symphysis to the corona glandis; and in this, will be perceived the dorsal vein lying in the middle, the arteries immediately external to the vein, and the nerve again external to the artery; the order being, from without inwards on each side, nerve, artery, vein: for a full description of the origin, course and termination of each of which, we must refer the student to the NERVOUS and VASCULAR systems.

CRURA, and CORPORA CAVERNOSA PENIS.—Each crus constitutes a hollow fibrous cone, with the base in front, and apex behind, containing a mass of vascular texture in its interior; it is connected to the ascending ramus of the ischium, as far back as the tuber, and to the descending ramus of the pubis, as far as the subpubic ligament, where both unite, and under the new name of corpora cavernosa penis, continue their course forwards, until they reach the corona, where they present a truncated appearance, being cut off obliquely, from above and behind, downwards and forwards, to support the glans, the fibrous tunic being still continued between them.

Relations.—In the perinæum the crura are covered by the skin, two

layers of fascia, erectores penis, and anterior fibres of the acceleratores urinæ. Each lies on the bone, and termination of the pudic artery; while in the penis, they have the common coverings of that organ, and are compressed towards each other, so that each wants one-fourth internally of being a perfect cylinder. In the groove beneath, which is the deeper of the two, is placed the corpus spongiosum urethræ, and in that on the dorsum, as already remarked, the dorsal vein with the artery, and nerve external to it; hence the appearance of a section of the organ, is not inaptly compared, by a celebrated French authority, to that of a double-barrelled gun.

Structure of the Corpora Cavernosa.—If a transverse section is made of the penis, it will be seen that a dense tunic of fibrous tissue, stronger inferiorly and externally, than superiorly and internally, surrounds the internal vascular structure, the fibres composing it being principally longitudinal, and sometimes presenting a reddish tinge in the neighbourhood of the pubis; and if a stream of water be allowed to play on the section, and its margins are held apart, numerous glistening fibres (trabeculæ) will be seen to radiate from the inferior and internal wall, to be ultimately attached to all points of the internal surface of the cylinder, in order to limit distention. By making a second cut with a pair of scissors, on one side of the middle line longitudinally, and washing the part so as to remove the blood, the following structure will be observed.

Septum Pectiniforme.—Forms a vertical imperfect partition between the corpora cavernosa, extending from the pubis to the extremity of those bodies; it consists of bands, with intervals between them, more or less large, but not of equal size. Those bands, always more complete behind than before, and thicker above than below, take an oblique direction, from above, downwards and forwards; and by careful manipulation we have been able to demonstrate, that this septum is double, each corpus cavernosum contributing the bands for the formation of its own side: its especial use being, to prevent over-distention of those bodies, as well as to allow a free communication between the cavernous structure of opposite sides.

Questionable Muscular Fibres.—Professor Müller has seen bundles of pale red fibres between the anastomosing veins, frequently connected by cross filaments, but at the same time, he observes, that when examined microscopically they do not present any resemblance to muscular fibres, nor did galvanism excite their contraction in a living horse. They differ from white fibrous tissue, in not yielding gelatine on long boiling; and from elastic tissue, in being soluble in acetic acid, and precipitable from the solution by ferro-cyanuret of potassium (*Müller's Physiology, by Bayly*, p. 250). Valentine believes that muscular fibres similar to those of the intestinal canal

are attached to the trabeculæ, and passing from thence to the walls of the veins may tend to dilate them, and thus cause erection (*Müller's Archiv.* 1838, p. 182). The crura are supplied with nerves from two sources—from the hypogastric plexus of the sympathetic, and also from the internal pudic; these ramify in the vascular network (Müller, *ut supra*), and Günther has observed, that when these nerves were divided erection was prevented in the horse; but his experiment only applied to the internal pudic branches. (*Meckel's Archiv.* 1828, p. 364.)

Vessels of the Corpora Cavernosa.—The artery arises from the internal pudic, as that vessel lies on the bone. It enters the crus obliquely, and running on the side of the septum pectiniforme, frequently communicates with its fellow. At the extremity of the corpus cavernosum it pierces the fibrous tunic, and enters the glans—a fact denied by many anatomists, but distinctly evident in a well-injected subject; and its branches are thus described by Müller. "The arteries of the corpora cavernosa have two sets of branches: one set are the ultimate ramuscules, which terminate in the minute radicles of the veins, and are destined for the nutrition of the part; the other set come off from the side of the arteries, and consist of short tendril-like branches, terminating abruptly by rounded, apparently closed, extremities, turned back somewhat on themselves. These are sometimes single; sometimes several arise by one stem, forming a tuft; I have named them 'arteriæ helicinæ.' They project into the venous cells, and are found principally in the posterior part of the corpora cavernosa and spongiosum urethræ."—(*Müller, by Bayly*, p. 252.) He believes that they pour their blood into the venous cells by their closed extremities; but Valentin objects to the existence of those helicine arteries, as he conceives that those vessels are dilated before their junction with the veins, and that they are surrounded by elastic bands, which curl at the extremities when divided, thus producing the apparently curved termination. The veins of the crura commence by cells, and their efferent branches are the dorsal veins, and certain deep branches that pierce the triangular ligament at the pubis, and open into the prostato-vesical plexus. The use of the crura, and corpora cavernosa is, to cause the erection of the organ by distention of the venous cells, and many causes have been assigned for producing this condition of those parts. Thus it has been attributed to the influence of the helicine arterial terminations (Müller); to the active dilatation of the venous cells themselves (Chaussier); to muscular dilatation of the veins (Valentin); to the action of the erector penis (Krause); to that of the compressores venæ dorsalis penis (Houston); to contraction of the dartoid tissue (Todd and Bowman); and more recently to specific nervous action.

The Corpus Spongiosum Urethræ, is that part of the urinary canal which commences at the bulb, and terminates at the glans penis. The bulb, which is sensibly dilated, is covered by the accelerator urinæ, and an expansion from the anterior layer of the triangular ligament, which connects it to the surface of that plane of fibrous membrane, as high as the symphysis pubis. It has been already stated that the corpus spongiosum lies in a groove, between the two corpora cavernosa; but when the integuments, and fascia have been removed, it still is covered by a proper investing fascia, which seems to be a continuation of the true suspensory ligament, and which splits on each side to enclose it, the deep layer connecting it to the fibrous corpus cavernosum, to which it adheres most intimately. If this fascia is now traced forwards, it will be observed to expand on the corona, and glans penis, which it covers, thus serving both to maintain the connexion between the corpora cavernosa, and glans, and also preventing over-distention of the latter. The figure of the glans penis when dissected from the crura, is capitate like a mushroom, and consists of the corpus spongiosum, which is expanded superiorly and laterally to complete it, the investing skin and urethral fasciæ connecting it to the corpora cavernosa, together with the terminal branches of the arteries of that structure.

Structure.—A vascular network similar to that of the cavernous bodies, investing the canal of the urethra with an expanded layer of variable thickness. On its superficial surface, some reddish longitudinal fibres are seen, believed by Home, Wilson, Hunter, and Valentin, to be muscular; this opinion has been latterly corroborated by Handcock, and Kolliker, and is still further supported by certain pathological conditions which it would be impossible to explain satisfactorily without admitting the fact of its muscularity.

Development of the Penis.—This organ appears about the sixth week, as a small papilla in the front of the anus, and as it advances forwards, exhibits inferiorly a canalicular depression. At the second month, two prominent folds, the rudiments of the future scrotum in the male; or of the labia, in the female, appear at either side; in the fourth month the canalicular cleft is closed, and becomes the urethra; and lastly, the lateral folds coalesce in the middle of the fifth month, constituting the raphe of the scrotum; but still the corpora cavernosa do not attain their full degree of development, until the period of puberty has arrived.

THE BLADDER AND ITS APPENDAGES.

To examine the urinary bladder, the student should make a lateral section of the pelvis, by sawing through the pubis, half-an-inch to

the right side of the symphysis; he should then separate the several connections of the bladder on the same side, and pressing the organ towards the left, saw through the sacrum, on a line with the pubic section; the rectum may now be filled with hair or tow, and the bladder inflated from the urethra, which should afterwards be secured with a ligature. The bladder in fœtal life is situated in the abdomen; but as the pelvis becomes expanded in the infant, it gradually sinks to the lower part of the hypogastric region, and with its still further expansion, falls into the cavity of the true pelvis, where it is found in the adult. In the fœtus, it is cylindrical in its outline, in the infant pyramidal, with the base above, and apex inferiorly at the neck, which at that period is the most dependent portion of the viscus; but in the adult, in consequence of the development of the inferior fundus, the figure is not only reversed, but the "bas fond" becomes the most dependent part; although the cervix can still be brought to that position by a slight inclination of the body forwards. In the empty state, the organ is triangular, with the base inferiorly corresponding to the openings of the ureters, and apex superiorly at the point of attachment of the urachus; but when in a condition of ordinary plenitude, its figure is ovoid, with the broader portion resting on and closely applied to the anterior face of the rectum. Should the organ, however, become over-distended by accumulated contents, owing to stricture or any other cause of this nature, its abdominal portion, placed among the yielding viscera, expands much more than the pelvic, and hence it is larger superiorly and also inclined forwards. Its axis likewise, varies according to the period of life; for while in the fœtus, and infant, it is vertical; in the adult, it is oblique, represented by a line passing from midway between the umbilicus and pubis, to the base of the coccyx, this alteration in its direction depending in a great measure on the altered axis of the true pelvis. This membranous reservoir is retained *in situ*, by the pressure of the surrounding parts, as well as by its ligaments, which are divided into two sets,—the false, five in number, being derived from the peritonæum, and are known as, the two lateral, two posterior, and one superior; and the true, derived from the vesical fascia, and called the two anterior, and two lateral.

False Ligaments of Bladder.—The lateral, are folds of peritonæum, which pass from the iliac fossæ, and levatores ani, to the side of the bladder, and contain in their anterior edge the vas deferens. The posterior ligaments are also processes of the same membrane, triangular in figure, with the apex below, between the bladder and rectum; and the base, which is lunated, looking upwards and forwards; the peritonæal recto-vesical *cul de sac* lies between the ligaments of opposite sides, and each contains between its layers the

ureter anteriorly, and the obliterated hypogastric artery posteriorly. The superior, is a single fold of peritonæum, with which three ligamentous cords are connected, namely, the urachus in the middle, and the obliterated hypogastric arteries, on either side; but all uniting the bladder to the rectus abdominis, and umbilicus. When those processes have been torn from their attachments, a fascial structure is still observed to afford fixity to the organ, forming what has been termed the true ligaments, and in order to understand fully their formation, it will be necessary to examine in detail the fasciæ connected with this region.

TRUE LIGAMENTS OF THE BLADDER.

The fascia iliaca, on leaving the brim of the pelvis, passes downwards over the iliacus internus, receiving at the pectineal line the name of pelvic, and as such descends into the cavity of the true pelvis, until it reaches the margin of the levator ani; here it splits into two layers —the external or obturator, which passing external to the levator ani, covers and adheres to the obturator internus, and is attached to the descending ramus of the pubis, and ascending of the ischium, as well as to the falciform process of the great sacrosciatic ligament, where both in conjunction form the canal for the pudic artery; arriving at the great sacro-sciatic notch, the fascia appears to form a kind of lunated margin; but such is not really the case, as tubular prolongations are sent on each of the parts which escape by that opening. From the point alluded to above, a thin layer is also continued inwards, to cover the pyriformis, and the sacral plexus, separating both from the internal iliac artery, and its branches; another known as the anal, or ischio-rectal layer, is likewise, prolonged on the perinæal surface of the levator ani, and this becomes continuous with the posterior layer of the base of the triangular ligament.

The second layer, given off at the edge of the levator ani, and called the vesical, passes downwards and inwards on the pelvic surface of that muscle, to which it most intimately adheres, and is attached in front to the back part of the symphysis pubis, from which it sweeps backwards, over the upper surface of the prostate gland, to the neck of the bladder, thus forming what has been termed its anterior true ligaments; while another reflection from the muscle itself to the side of the prostate, and from thence to the neck of the bladder, constitutes the lateral. Still it must not be supposed that those ligaments are separate and distinct processes, as, strictly speaking, they are nothing more than thickened portions of the same fascia, the continuity of the whole being completely preserved, by

thinner expansions that pass between one and the other, though the difference in character between this connecting tissue, and the ligaments themselves, is sufficiently obvious to entitle the latter to the name that has been conferred upon them. At a future stage of the dissection, when we come to examine into the anatomy of the prostate, we will find that those ligaments, with the expansion between them, form at least three-fourths of the capsule of this gland, and that the remaining, or inferior fourth, is constituted by the posterior layer of the triangular ligament, with which they become directly continuous. The anterior true ligaments, are exceedingly strong and dense, and are exposed by drawing the bladder backwards from the pubis; on their superior aspect, they are concave and smooth, and the dorsal vein of the penis runs backwards in a groove between them; the external edge of each is united with the lateral ligament at the pubic attachment, while the lower margin receives the attachment of the posterior layer of the apex of the triangular ligament, and the superior, the fascia transversalis; posteriorly those ligaments, both anterior and lateral, are so intimately connected with the longitudinal muscular fibres of the bladder, that some authors have not hesitated in considering them to be, the tendons of those muscles.

After forming the ligaments just described, the vesical fascia continues its course backwards and downwards, still on the internal surface of the levator ani, until it reaches the rectum; here it splits into two layers, one of which passes in front of, and the other behind that viscus, both ultimately becoming continuous with each other in the middle line; but the anterior layer, or that which lies between the bladder and rectum, again divides in order to form a capsule for the vesiculæ seminales, and vasa deferentia, which lie between those viscera. At the base of the prostate gland, this layer unites by its anterior inferior margin with the posterior layer of the triangular ligament, forming the recto-vesical or Tyrrel's fascia, whilst superiorly it is continued upwards, on the posterior aspect of the bladder to its summit, and from thence downwards on its front and sides, to become continuous with the anterior and lateral true ligaments; constituting in fact the second or areolar coat of the bladder, to be presently more particularly described.

The Bladder, consists of a summit, body, inferior fundus, and cervix, following each other from above downwards in the order in which they are enumerated; but anatomically, it is divided into six regions,—an anterior, posterior, two lateral, a superior, and inferior. Of these, the anterior corresponds to the recti, particularly when the organ is either wholly or partially distended, to the superior surface of the pubis, anterior true ligaments, triangular ligament, and prostate gland; the posterior, to the posterior false ligaments and their con-

tents, recto-vesical *cul de sac*, and the convolutions of the ileum and rectum; the lateral, to the lateral true and false ligaments, levatores ani, and vasa deferentia, with the obliterated hypogastric arteries; the superior, to the superior false ligament, hypogastric arteries, and urachus, with the convolutions of the small intestines when in the erect position; and the inferior, to the recto-vesical fascia, rectum, vesiculæ seminales, and vasa deferentia.

The coats of the bladder are five in number, and are known as serous, cellular, muscular, deep cellular or submucous, and mucous, each of which we will now proceed to examine in order.

Serous Coat, is a partial investment only, the anterior region being wholly uncovered, while the posterior is altogether covered; the lateral receives an investment as far forwards as the vasa deferentia, or about one-half; the superior, as far as the urachus and obliterated hypogastric arteries; and the inferior, as far as the base of the vesiculæ seminales, or openings of the ureters. Thus, about the posterior half of the whole organ, is invested by peritoneum; but there is a greater amount covered when it is distended, as it expands between the layers of the false ligaments, extending them on its surface. This serous coat is but loosely attached to the subjacent tissue, and in the collapsed condition of the bladder, presents many transverse rugæ, particularly posteriorly. In a surgical point of view, however, the peculiar arrangement of the peritonæum to the bladder, is a matter of paramount importance, as two very important operations for retention of urine—the one above the pubis, and the other through the rectum—can be performed, without subjecting it to injury from the trocar. With respect to the first, as we have already remarked, the entire of the anterior surface of the organ, is uncovered by serous membrane; hence it naturally follows, that according to the amount of distention, so will be the consequent ascent of this uncovered portion above the pubis, presenting a triangular space, bounded on either side, by the obliterated hypogastric arteries, below, by the crest of the pubis, and the inner portion of Poupart's ligament; and its apex extending to a distance, generally midway between the bone, and umbilicus. In the position just described, ample room is afforded for the operation, and the only risk that can be incurred is, that the point of the instrument, if directed too obliquely, may glide downwards along the anterior wall of the bladder into the cellular space between it and the symphysis, and so give rise to dangerous consequences. With respect to the second space uncovered by peritonæum, it is found at the base of the bladder, and, like the preceding, is of a triangular figure, with the apex in front at the prostate, its base behind at the recto-vesical cul de sac, and its sides formed by the vesiculæ seminales, and vasa deferentia.

It will be seen at once, that the size of this space must always depend on the position of the fold of peritonæum posteriorly; and we have been taught by repeated observation to agree most fully with the statement of Mr. Guthrie, who observes that it is always a matter of uncertainty to what extent it may be prolonged downwards and forwards, and although, as a general rule, the distance between it and the prostate, may be said to range from three quarters of an inch in the collapsed condition of the bladder, to two inches and a half in its abnormally distended state, still those measurements can never be relied on as being uniformly correct. Hence the danger of perforating the peritonæum, which no amount of skill or foresight can possibly guard against, must always be incurred; and in addition, it should be invariably borne in mind, that after piercing the wall of the rectum, a strong and unyielding fascia still intervenes between it and the bladder, quite capable of diverting the point of the instrument, introduced, as it must be, very obliquely, upwards and backwards; and we know how very slight a deviation in this direction may implicate the peritonæal cul de sac.

Cellular Coat, is derived, as already described, from the vesical fascia, splitting in fact, to invest the organ; it adheres most intimately to the subjacent muscular fibres, sending processes to invest the several fasciculi, and sinking deep, to be attached to the deep cellular coat; it is strong where the organ is deficient of serous covering, and particularly so where it forms the recto-vesical layer at the base of the bladder, and supports the veins in that situation. The several arterial branches which supply the organ, likewise ramify in this tissue, and fully explain why in rupture, the hæmorrhage is prevented, by the contraction of the subjacent muscular coat, from entering its cavity, and its taking place into that of the pelvis.

Muscular Coat, is well marked, and much redder in colour than the fibres of the small, or large intestines; but it somewhat resembles those of the rectum, and œsophagus, at least in colour and thickness. It forms one uninterrupted plane, but still, in consequence of difference in direction and arrangement, it is described as consisting of longitudinal, oblique, circular, and reticular planes or sets.

LONGITUDINAL, known as the detrusores urinæ, strong and distinct on the anterior and posterior surfaces, arise from the urachus, and descend on the fore and back part of the bladder; those on the side being oblique in direction, and evidently nothing more than the longitudinal fibres deviating from their usual direction; but although the urachus is stated as the superior attachment, still on either side of it, numbers may be seen passing over the summit in loops; both anterior and posterior fibres being continuous, and blended with each other; while again, others are observed to dip deeply, like the cardiac

fibres at the apex of that organ, to reach the deep reticular layer; and, in one case, where there was a very slight thickening of the muscular tunic, the arrangement at the summit forcibly reminded us of the crucial weaving of the "apicial" bands of the heart in their anatomy. The inferior terminatiou of these fibres, may be divided into anterior, posterior, and lateral, and each may be again subdivided into a superficial, and a deep layer:—of these, anterior superficial, strong and interlaced, and sometimes, but by no means constantly, decussating, are inserted iuto the symphysis pubis by the anterior ligaments, which some authors describe as the tendons of these muscles; the anterior deep, are few in number, and weaker than the last, some being attached to the superior edge of the prostate, or when the gland is deficient above the urethra, passing along its surface as far as the triangular ligament; others, again, sink deep, a few being inserted directly into the cervix, but the greater number returning on themselves, unite with the superficial layer, or bending round the cervix laterally, are implanted into the lateral edges of the cervical fibrous floor; the superficial lateral, are attached to the capsule of the prostate, and to the tissue between it aud the structure of the gland, the deep passing, some into the fibro-glandular mass, while others are inserted into the cervix. The posterior superficial, consist of two bands, that enter the notch in the posterior edge of the prostate, and having become flatteued above the seminal vesicles, can be traced to the verumontanum, or even to the membranous portion of the urethra; while the deep, form a distinct plaue, between the vesiculæ seminales, and bordered by Bell's muscles; and these, which are the thickest lougitudinal fibres of the organ, terminate in the fibrous floor of the neck.

Circular Fibres, are principally found in the lower third of the organ, forming a series of rings around it, some of which are parallel, while others iuterlace very obliquely. At the base of the trigone they form a dense band between the orifices of the ureters, to the inner lips of which they are attached, for the purpose, according to Bell, of dilating those tubes, iu order to afford a more ready passage for the urine; while still lower, they become continuous with the annular fibres of the neck, but above, or in the region of the superior fundus, they are very indistinct, and sometimes scarcely capable of demonstration.

Reticular Fibres.—Are best observed, by dissecting off the mucous membrane, from within; in perfectly healthy organs however, they are not very evident; but in the condition known as sacculated bladder, they are most distinct, and the mucous membrane becomes protruded in the intervals between them, frequently in large pouches. These, as

well as the oblique fibres, are always better marked on the posterior and inferior aspect of the bladder than in any other situation.

Submucous Tunic, or Internal Cellular.—Weak above, but exceedingly strong below, forms the bed in which the terminal twigs of the arteries, and nerves, are distributed; and hence is designated by Bichat, the nervous coat. Both the internal, and external cellular tunics, tend to preserve the connexion of the muscular fibres, whilst they at the same time assist in preventing over-distention.

Use of the Muscular Coat.—To diminish the capacity of the whole organ, while the deep fibres assist, at the same time, in expanding the neck. In their action they are much more energetic, than the similar coats of other hollow viscera; and receive the principal amount of the blood supplied to the organ. The external layer, or detrusor urinæ, is of a mixed character, and when the bladder is in the ordinary state of distention, the stimulus of pressure exercised by the urine, is the excitor of reflex action, not only on the detrusor urinæ itself, but likewise on the muscles associated with it, in the act of expulsion, viz.—the levatores ani, abdominal muscles, and diaphragm, with the acceleratores urinæ. The cavity of the bladder, may now be laid open anteriorly, from above to within an inch of the prostate, and the several parts, brought into view, examined in succession.

Mucous Membrane.—Thin, and of a light reddish tinge, pale in the summit, and body, but more vascular inferiorly, is smooth in all situations, except when collapsed, when it becomes closely corrugated. It does not possess the same amount of sensibility as that lining the urethra, and such a very small amount of mucous secretion is found upon its surface, that some authors have denied the existence of mucous follicles altogether; still they are present in large numbers, but are exceedingly small and obscure. The cervix diminishes as it approaches the urethral orifice, which represents a semi-ellipse, with the long axis placed transversely. Projecting into its lower part is a small papillar elevation of mucous membrane, called the *luette vesicale*, or *uvula vesicæ*, which is not by any means constant; or at least is so minute as to be incapable of demonstration; while on either side of it, folds sometimes exist, with their concavities directed forwards, which are formed by the expansion and bifurcation of the verumontanum posteriorly. Amussat conceived that he had detected transverse muscular fibres in connexion with them, and named the elevated crest *the pyloric valve;* but this is also a variable arrangement. Posterior to the uvula, the structure of the bladder is pale, but thick, and highly sensitive; this space is called trigonum vesicæ, and is triangular in shape, with the base posteriorly, and the apex at the uvula; bounded laterally, by two elevated bands, extending from the vesical orifice of the ureter, to the uvula; and

posteriorly, by a curved line, with the convexity directed forwards, drawn between the ureteric orifices. At the sides, this space measures about one inch and a quarter, and in the middle three-quarters of an inch. The lateral bands have been described by Bell, as muscles arising from the vesical orifice of the ureter, and inserted into the uvula, and he regards them as being of use to preserve the obliquity of that tube, and prevent regurgitation when the bladder is distended. Mr. Guthrie however believes they are of utility in preserving the patency of these openings, when the bladder is fully distended; and Amussat, that they draw the uvula downwards and backwards and thus dilate the urethral orifice. The fact of their not being present in the female, would go far to prove that their importance in preventing regurgitation is somewhat exaggerated, as, the following experiment would seem to prove. "In a subject, the bladder was carefully opened, and a sharp-pointed bistoury inserted beneath them, so as to divide all their fibres; a quantity of fluid was then introduced into the organ, the opening, and urethra being secured. Forcible pressure was now made, but no fluid escaped into the ureters."—(Dr. Harrison, in *Todd's Encyclopædia*, Art. *Bladder.*) We have examined this portion of the bladder with much care, and have found these muscles in many instances absent, their place being supplied by an elastic band, similar in structure to the trigone itself, which always shews a well-marked elastic character. On tracing this band forwards, it expands around the urethral orifice, becoming much thickened, and receiving externally the deep insertion of the longitudinal fibres of the bladder; in some cases only, could any circular muscular fibres be detected, so that their presence cannot be essential to the functions of the part. Dr. Harrison describes the opening as consisting, superiorly and laterally, of muscular fibres, the floor of the neck being merely fibrous; the retention of the urine in the bladder would therefore in part, depend on muscular contractility, assisted in some degree by elastic pressure *(Todd's Encyclopædia*, Art. *Bladder*, and Guthrie, *on the Sexual and Urinary Organs).*

The Openings of the Ureters, are two oblique slits, at the posterior and lateral angle of the trigone, with the long measurement of each aperture directed obliquely forwards and inwards; if a fine probe is introduced into the opening, and passed upwards, it will be seen that the tube first enters the muscular coat directly, and then passing obliquely for about six lines between it and the next, pierces the fibro-elastic tissue of the trigone, at its posterior external angle. At the point of termination there is a direct fusion of the fibrous coat of the ureter with the trigone; the reticular muscular fibres, and

external cellular coat of the bladder being continued on its external surface, for some distance upwards.

Arteries of the Bladder.—Are divisible into anterior, and posterior. The anterior, are several twigs, arising from the obturator and its transverse pubic branch; while the posterior, consist of superior, middle, and inferior: the first arising from the contracted hypogastric artery, near the summit of the organ; the second derived directly from the internal iliac; and the third, the most numerous, being branches of the pudic, sciatic, and middle hæmorrhoidal, which are distributed to the inferior fundus.

Veins.—Are situated at the inferior fundus, where they form a plexus, receiving in front the prostatic plexus, laterally the dorsal veins of the penis, and also the branches of the vesical veins. In old age these veins are often large and varicose, sometimes containing phlebolites, or vein-stones; they are supported by the recto-vesical fascia, and surrounded by lax areolar tissue; they frequently adhere to the fascia, particularly in advanced life, and if divided in the operation of lithotomy, give rise to troublesome hæmorrhage, because their mouths are kept open by their adhesion to the fibrous structure. These veins pour their contents into the internal iliac, by two efferent venous trunks provided with valves.

The Absorbents of the Bladder, are divisible into two sets,—a superficial, and a deep plexus; the efferent vessels found at the base, in the vicinity of the veins which they accompany, pass through the lumbar glands, in their course to the common lymphatic receptacle. Cruveilhier once saw them filled with pus, in a case of catarrh; but still, their existence has been disputed, and the fact of the watery parts of the urine, being absorbed during retention, proves nothing, as this function may be, and is probably, performed by the veins. The nerves of the bladder, are derived from the sacral plexus of the spinal, and the hypogastric plexus of the sympathetic system.

The Urethra, is divided into three portions,—prostatic, membranous, and spongy; the first being one inch and a quarter in length, the second from a quarter to three quarters of an inch; the remainder of the canal, which is from nine to ten and a-half inches long, is formed by the corpus spongiosum urethræ.

Prostate Gland, situated at the commencement of the canal, resembles in shape a horse-chestnut, with the base behind, and apex in front; it is convex inferiorly, but flattened above, and surrounded on its surface by a dense capsule, formed above by the anterior vesical ligaments, on either side by the lateral, and inferiorly by the reflected layer of the triangular ligament, a plexus of veins called the "prostatic," being found between the capsule, and the proper structure of the gland. As it lies in position, its boundaries are as

follows,—above, the anterior vesical ligaments, and dorsal vein of the penis; below, the rectum; laterally, the external true vesical ligaments, and levatores ani (compressores prostatæ); posteriorly, the neck of the bladder, vesiculæ seminales, and vasa deferentia; and anteriorly, the triangular ligament, membranous portion of the urethra, Wilson's, and Guthrie's muscles, and the ante-prostatic glands. The gland measures, from apex to base, fifteen lines; transversely at base, eighteen lines; vertically at base, twelve lines (Cruveilhier); but in thirty-two cases that we measured, the mean length was one inch and a third; the width at the base one inch and a quarter; the vertical a little more than three-quarters of an inch, which are somewhat less than what is stated by Cruveilhier. The neck of the bladder, in some cases, is surrounded by its base; but this is certainly exceptional, as in the majority of instances, the gland is lunated, so as to exclude that part altogether. The urethra runs through its substance, but not in its middle, as two-thirds are inferior, and one-third superior to it; sometimes however, it is altogether deficient above the canal, and then the longitudinal fibres of the bladder, compensate for its absence. It is divided into two lateral, and a middle lobe (Home); the former being united anteriorly, but posteriorly they project backwards on each side of the vesical cervix, which they cover, more on each side than above or below; on the under surface there is no actual line of separation between them, with the exception of a mere furrow, always very obscure in its outline. The middle lobe is exposed, by turning the bladder on its forepart, and throwing forwards the vesiculæ seminales, and vasa deferentia, when it may be seen, lying between the common ejaculatory ducts and the floor of the urethra, its usual appearance being that of a flat band, uniting the lateral lobes posteriorly; but the nipple-shaped projection of Home, is in its natural healthy state, unquestionably a fallacy. With respect to its relations, they are as follows:—below, the ductus communis ejaculatorius, prolonged muscular fibres from the bladder, and the junction of the lateral lobes; above, the mucous membrane, and uvula; and on each side, the lateral lobes. The gland may now be laid open, by dividing its upper part, when the urethral canal lined by mucous membrane, pale and loose in the middle line, but closely attached to the other parts of the surface, will be exposed.

Prostatic Portion of Urethra, is contracted at both extremities, but somewhat expanded in the middle, and slightly concave upwards, the inferior part being called the sinus; on either side of the middle line, from ten to sixteen openings are observed, of sufficient size to admit the introduction of a bristle, while with a low magnifying power, innumerable smaller orifices are visible; through the former the mucous membrane is continued down, into an equal number of

pouches or crypts, while the latter are merely simple involutions of that membrane, not passing, like the first, into the proper structure of the gland, but terminating in the submucous tissue. In the middle line an elevated ridge called the verumontanum, is also apparent, and should now be examined.

VERUMONTANUM, commences by a slight elevation of the lining membrane at the membranous portion of the urethra, and passing backwards, the fold first separates to inclose the seminal papilla, when it again unites, but divides posteriorly a second time, into two frænula, which bound the floor of the cervix, at its vesicular extremity on each side of the luette; the fossette formed by the first separation of the verumontanum, is called the sinus pocularis, and the projecting papilla, the seminal caruncle, the latter resembling in its appearance one of the papillæ circumvallatæ in the tongue. At this point occurs, the minute opening of the ductus communis ejaculatorius.

The structure of the prostate, cannot be well determined when examined with the naked eye, as it appears to be of a homogeneous nature; but with a low magnifier, and after maceration in spirit, a section exhibits all the characters of a soft subfibrous texture, more dense, as it surrounds the urethra, than on the surface. The idea of a glandular structure is perfectly gratuitous, and although it is true that there are some involutions of the mucous membrane into its tissue, they are so very few in comparison to the size of the body that they would seem rather to refute, than confirm, the opinion of its glandular nature. When the capsule is removed, the body is easily torn, particularly in the longitudinal direction, the lacerated surface appearing to consist of fibres, which are apparently prolonged from the muscular tunic of the bladder. The use of the prostate is to fix the neck of the bladder, and to preserve the position of the seminal ducts, its follicular secretion not possessing any manifest importance in the function of generation, unless indeed it may act in some degree to neutralise the acidity of the seminal secretion.

In the dissection made for the examination of the middle lobe of the prostate, an opportunity will be afforded for studying a cavity, first discovered by Morgagni, and subsequently minutely described by Weber, as the vesicula prostatica, but now connected with the name of the latter physiologist as the Weberian organ. It is a small, flask-shaped vesicle, from a quarter to half-an-inch in length, and about two lines in width at its dilated portion, lying obliquely, with the constricted neck turned upwards and forwards, and the fundus downwards and backwards; bounded above, by the uvula vesicæ, by the elastic tissue at the floor of the vesical cervix, and by the middle lobe of the prostate; below, by Tyrrel's fascia; and laterally, by the

common ejaculatory ducts, between which it is imbedded in condensed areolar tissue; its duct terminates on the anterior part, or declivity, of the verumontanum, between the seminal openings. This organ is conceived by some to be a trace of the female uterus, and by others as the remains of the duct of the Wolffian bodies; but in order to obtain a good view of it, the parts must be recent, and all pressure on the prostate carefully avoided, as otherwise its rupture may lead in some cases to the erroneous conclusion of its absence. In man, it is always present; and indeed, the same remark may be applied to many of the class mammalia.

Vesiculæ Seminales.—These are symmetrical organs, of an ovoid figure, situated at the base of the bladder, diverging posteriorly, and converging anteriorly; each vesicle being bounded internally, by the vas deferens; externally, by the lateral true ligaments; posteriorly, and externally, by the ureter, and *cul de sac* of the peritoneum; anteriorly, by the prostate; inferiorly, by the rectum; and above, by the inferior fundus of the bladder, and trigone; they are grey in colour and also lobulated, being in length about two and a half inches; in width half-an-inch, and in depth, a quarter of an inch. They vary however, in size, being small in the child and in old age, but large in the adult. The left is also somewhat smaller than the right, and their surface is invested by a dense fibrous layer, formed by the splitting of the recto-vesical fascia, which also includes the vasa deferentia in the same capsule; they are likewise moveable on the rectum, and bladder, being connected to the latter by a yellowish, fine, areolar tissue. A section of the vesicle, exhibits a cellular structure, with a dense connecting fibrous bed; but if it is subjected to maceration, so as to destroy the fibrous tissue, it can be unravelled into a tube about nine inches in length, with dense tunics, resembling those of the vas deferens. The anterior extremity is narrow and prolonged into a duct, which joins the vas deferens to form the ductus communis ejaculatorius, the vas deferens being here flattened and sometimes lobulated; the common ejaculatory duct, from half to three-quarters of an inch in length, enters a notch in the base of the prostate, losing the dense deferential tunic at this point; it next passes upwards and forwards, above the junction of the lateral lobes, and below the middle, and opens on the seminal papilla of the verumontanum in the prostatic portion of the urethra. The oblique passage of the duct through the prostate, and for so great a distance, obviates in a great measure the tendency to an expulsion of the semen during micturition, and this is further aided by the column of urine always pressing on the thin and unresisting duct, during that state, thus precluding any attempt at transmission by those canals.

The vesiculæ seminales, are certainly reservoirs for the seminal

fluid when not required, and this is proved by several circumstances: firstly, that in animals where coitus is rapid they are invariably present, but when, on the contrary, that act is prolonged, as in the canine species, these sacs are absent; secondly, the semen is perfect in all its essential constituents before it reaches them, and consequently they cannot add any important element to that secretion; thirdly, fluid injected into the vas deferens passes first into the vesiculæ, before it reaches the urethra. During the act of coitus, the irritation of the glans excites a reflex action of the levatores ani, by the contraction of which, the secretion is urged from the vesicles into the bulb of the urethra, from which it is then ejected in jerks, by the spasmodic action of the accelerator urinæ. But in opposition to this view it may be remarked, that Hunter found the vesicles dilated even to distention, immediately after coitus, and in a case where the testicle had been removed, the vesicle on the corresponding side was discovered to be quite full. Again, spermatozoa are not observed in the fluid taken from the vesiculæ in any great amount, and in the elephant there exist special seminal reservoirs, although the vesiculæ are present.

Membranous Portion of the Urethra, extends from the prostate to the bulb, and is arched upwards and forwards, lying partly within and partly without the pelvis; it varies in length above and below —being from three-quarters of an inch to an inch superiorly, and about half-an-inch inferiorly, this disparity resulting not only from its arched form but likewise from the direction of the bulb, which is downwards and backwards, overlapping the lower surface of the canal, and thus diminishing the space for the opening of the urethra in lithotomy. It perforates the triangular ligament, one inch below the symphysis pubis; and as the two layers of this ligament are somewhat separated at this point, the greater part of the membranous canal is found between them, while as it passes through, a process is reflected forwards on the bulb, and a similar one backwards on the intrapelvic portion of the canal and under surface of the prostate, forming, in fact, the inferior part of the prostatic capsule; and afterwards becoming continuous with the recto-vesical layer, or Tyrrel's fascia. But this should not be confounded w th the posterior reflection of the base of the ligament, which lying below the levator ani, really separates the two portions of this muscle from each other. The membranous portion of the canal, is fixed and unalterable in its position, and is the most contracted division of the urethra, except at its commencement and termination. It is peculiar in structure, having from within outwards, first, the mucous membrane, pale and fine, almost devoid of lacunæ, and intimately adherent to the subjacent structure, which is dense and fibrous, but diminishing in density and thickness towards

the apex of the prostate. More externally, a spongy venous structure is moulded on its surface; more externally still, is an inflection backwards from the anterior layer of the triangular ligament; and lastly a fibro-muscular ring occurs, variously developed in different cases; whilst the intrapelvic portion is covered, by the posterior reflection of the triangular ligament. Intercepted between the lower aspect of this portion of the canal above, the rectum behind, and bulb in front, a space has been described called the recto-bulbar, averaging about three quarters of an inch between the two last named parts, and it is here Mr. Guthrie advises the urethra to be opened in impermeable stricture, an operation which in its facility of execution exemplifies the advantage of connecting the lessons derived from practical anatomy with operative surgery.

Spongy Portion of the Urethra, derives its name from the peculiar erectile vascular tissue, already described, which surrounds it. On laying the canal open, the mucous membrane appears pale and soft, but is comparatively vascular, during life; it also presents several longitudinal, and oblique folds, with two sets of mucous lacunæ; the parvæ, which are very numerous on the floor, and sides of the canal, and the magna, which is single, and found on the roof, about three-quarters of an inch behind the anterior orifice, within an ovoid dilatation, called the fossa navicularis; at the commencement of the spongy portion, the sinus of the bulb is situated, and into its cavity, which is not at all as large as might be anticipated from an external examination, the openings of the ante-prostatic ducts are usually observed to open; the mucous membrane, at the urethral orifice, is exceedingly fine, and closely connected to a strong fibrous layer external to it, which preserves the outline of the opening, and prevents excessive dilatation.

LITHOTOMY.

The operation for removing a calculus, from the male bladder, consists essentially in arriving at the most posterior portion of the urethral canal, laying it open, and then extricating the foreign body through the artificially dilated space. To accomplish this object, two different modes of proceeding have been adopted,—the first, in which the operation is completed on one side (Cheselden); and the second, where both sides of the perinæum are made to participate equally in the operation (bilateral—Dupuytren). The former, is that principally followed by British surgeons, and the following is the manner in which it is performed. The patient being drawn to the edge of a table of a convenient height, with the buttocks supported on a pillow, and the wrists secured to the outer side of the ankle-joint,

an assistant stands at each side to divaricate the thighs, and also to secure the staff firmly against the symphysis pubis. The staff, which should be introduced before the patient is placed in the requisite position, has a groove on the convexity, or sometimes a little to the right side, which does not reach the point, but stops abruptly a few lines from its termination, to restrain the knife from passing too far into the cavity of the bladder. In performing the operation, the scrotum should be elevated, and any scattered hairs shaved from the surface of the perinæum; the first incision, should commence at the left side of the raphe, about one inch and a quarter in front of the anus, and be continued downwards and backwards, to midway between the anus and tuber ischii, its extent being about three inches. The knife should pass through the skin, fasciæ, and fat, with some of the fibres of the superficial sphincter; and in the division of those parts, the long perinæal artery may escape, from being parallel to the line of incision, but the transverse artery (superficial) is always divided. The second incision, should begin half-an-inch below the last, in order to avoid the artery of the bulb, and be then carried backwards in the direction of the former, so that the knife will pass through the triangular space between the erector penis, and accelerator urinæ; and divide the base of the triangular ligament, transversalis perinæi, anterior fibres of the levator ani, and Wilson's muscles. The fore-finger of the left hand is now to be introduced into the wound, until the nail presses the membranous wall of the urethra into the groove, when the point of the scalpel, thus guided by it, is passed into the urethra, for about a quarter of an inch in length. During this proceeding, the fore-finger bears up the bulb, while the middle, and ring fingers depress the rectum. The probe-pointed bistoury, or the knife recommended by Mr. Peile, now completes the operation, the blunt point being passed into the groove, of which fact the operator should make himself perfectly certain; the knife, with its edge directed obliquely downwards and outwards, and the left hand grasping the staff, is pressed into the bladder, while the staff is gradually depressed, in consonance with the axis of the prostate, so that the incision may be direct, and the prostate at the same time raised, as far from the rectum as possible. It is always the better plan, while the knife still lies in the neck of the bladder, for the operator to pass the left fore-finger into that cavity, along the back of the instrument; this will always inform him if a sufficient section of the gland has been accomplished; if such has not been the case, the knife may be pressed by the finger downwards and outwards, to divide a sufficient space for the extraction of the calculus, but if a blunt gorget is used, it is not necessary, as it will sufficiently enlarge the prostatic section by laceration. In this third incision, the mem-

branous portion of the urethra, with its muscles, and the fibres of the levator ani, undergo a further division, as well as the two anterior thirds of the prostate gland, but no further.

Remarks.—It is evident from the above description that in the first incision, the transverse, and long perinæal arteries, may be wounded; and in the second, the artery of the bulb, and external hæmorrhoidal, may suffer a similar fate; while in the third, the internal pudic, may be injured, if the edge of the knife is too much lateralized, and if not sufficiently so, the rectum may be opened.

The bilateral operation as recommended by Dupuytren, is rather peculiar in its character, and is thus performed:—A semilunar incision is made from the tuber ischii of one side to that of the opposite, the convexity looking forwards towards the scrotum, and being about eight lines in front of the verge of the anus. The insertion of the superficial sphincter, the central tendinous point of the perinæum, with the base of the triangular ligament, are then divided, the verge of the anus being at the same time drawn backwards, so as to avoid injuring the rectum; the thumb or fore-finger nail having been then inserted into the groove of the staff, in the upper and anterior boundary of the recto-bulbar space, the urethra is opened, and the lithotome, a sheathed instrument with a concealed double blade, having been then passed into the urethra, is pressed into the bladder, with its convexity towards the rectum. The staff is now withdrawn, and the blades of the lithotome protruded, the instrument having been previously reversed, so as to present its concavity downwards, and withdrawn in a direction downwards and forwards, in the axis of the original wound, making in fact a flap of the lower part of the prostate; the finger is then to be introduced into the bladder, to direct the forceps to the stone. Dupuytren, ascribes the following advantages to this operation:—That the wound is in the widest part of the outlet of the pelvis; and the operation is easy of execution; that it is a direct opening; and the ejaculatory ducts are more likely to escape injury; but above all, that there is more space for the extraction of a large stone, and that it is applicable to both sexes. Mr. Liston however, is of opinion, that such an operation is rarely required.

FEMALE ORGANS OF GENERATION.

The Female Organs of Generation, are divided into copulative and formative, or external and internal; the former consisting of the mons veneris, labia majora and minora, clitoris, and the vagina; while the latter include the uterus and its appendages, or the broad peritoneal ligaments, with the Fallopian tubes, and ovaries.

THE COPULATIVE ORGANS.

Mons Veneris, is formed by the prominent pubic symphysis, and covered by a strong layer of integument, with a cushion of dense fatty matter interposed between them; the surface, as the rule, is studded with strong hairs at the age of puberty; but they are occasionally absent altogether.

Labia Majora, are two tumid folds of integument, continuous above and in front with the mons; as they descend, they enclose a space between them of an elliptical figure, named the vulva, and again unite behind in the fourchette; they are rounded anteriorly and externally, and much thicker superiorly and anteriorly, than below and behind, and covered by a few scattered hairs; internally, they are smooth, and lined by a mucous membrane, and always in contact with each other in the virgin state; but as constantly more or less apart, after sexual intercourse has once taken place. The areolar tissue interposed between the folds of integument that invest them, is lax and much disposed to œdema in difficult parturition; and the vessels also, being only slightly supported, sometimes rupture, producing the disease termed "thrombus," as described by Dr. Montgomery. Posterior to the fourchette, and anterior to the anus, there is a space, from three quarters of an inch to an inch in extent, where the skin, fine, thin, and highly elastic, presents a brownish colour, and forms the perinæum.

Labia Minora, are exposed by separating the labia majora, internal to which they lie, and are formed of a double fold of mucous membrane, which commences at the inner surface of the greater labia; small at first, they gradually increase as they ascend, and ultimately divide into two folds, one of which is attached to the clitoris, forming the *frænum clitoridis*, while the other, uniting with its fellow above that point, constitutes the *præputium clitoridis*. The mucous membrane of which these folds are composed, is highly vascular, and furnished with a number of simple follicles, that lubricate the surface with a continual secretion. Those folds are large in the infant, and particularly so in the Hottentot, where they project far beyond the labia majora; but we have observed them occasionally, to be altogether absent.

The *Labia minora*, are also termed, the Nymphæ.

Clitoris, appears as a projecting tubercle, half-an-inch below and behind the anterior commissure of the vulva, and immediately posterior to the union of the nymphæ; the surface is covered by a vascular mucous membrane, which is remarkable for its sensibility; but its structure will be better understood by raising the integument of the labia majora, and the mucous membrane of the nymphæ, and

then cleaning away some areolar tissue. It will then become apparent that the clitoris is formed by the union of the crura clitoridis, which resemble in many respects the crura penis; they arise narrow from the rami of the ischium and pubis, and running upwards, forwards, and inwards, converge and unite about a line in front of the symphysis pubis; they then curve a little downwards, and terminate in a pointed extremity, which is convex superiorly and posteriorly, and concave inferiorly, presenting a groove below, in which the urethra is lodged. On the surface of these tubes, which are composed of erectile tissue, a small erector is visible, while the sphincter vaginæ, splitting superiorly to inclose the clitoris, resembles to a certain extent the accelerator muscle in the male.

Meatus Urinarius.—This opening, situated about an inch below the clitoris, and immediately above the anterior edge of the vagina, in a space called the *vestibule*, is full, prominent, and projecting in the adult, but depressed in the old subject, and is always closed, except during micturition.

Vagina, a membranous canal, extending from the uterus above, to the vulva inferiorly, constitutes also the organ of copulation in the female. The whole canal is conical in shape, being large and expanded above, narrow and constricted inferiorly, not straight but curved, with the concavity directed upwards and forwards, the anterior wall being about four inches in length, and the posterior five; it presents for description, an anterior and posterior, with two lateral surfaces; and a uterine, and vulvar extremity. Anteriorly, it corresponds to the base of the bladder, to which it is united by areolar tissue, and a process of the vesical fascia; while more inferiorly, it receives the urethra in a canal, grooved in its structure; posteriorly, to the recto-vaginal pouch of the peritonæum in its upper fourth, and in the remainder to the rectum, to which it is united by lax areolar tissue; laterally, to the broad ligaments of the uterus superiorly, and more inferiorly to the fibres of the levatores ani. The superior or uterine extremity, embraces the cervix uteri, to which it seems to be attached by the peritonæum externally and posteriorly; internally, by the continuity of the mucous membrane; and intermediately, by the fusion of the fibrous layers of the canal with the elastic tissue of the cervix uteri; the inferior or vulvar extremity, usually closed and compressed laterally, is surrounded by the sphincter vaginæ, which, arising from the sphincter ani, and a dense, tendinous point posteriorly, divides into two portions that pass forwards, and surround the extremity of the vagina, where they unite above and in front, but again separating, are inserted by two slips into the dorsum of the clitoris.

Structure.—The vagina is composed of five distinct layers, which

may be thus enumerated from within outwards :—most internally, mucous ; then internal fibrous; external to this, an erectile layer; still more externally, the external fibrous coat; and lastly, an areolo-contractile tissue, resembling the dartos.

The MUCOUS layer, continuous with the fine integument at the vulva, covers the sphincter vaginæ, and forms in the virgin a semi-elliptical fold at the orifice, named the *hymen*, which occupies generally the posterior or inferior fourth of the opening when expanded; but in some cases forms a complete occluding membrane, with a small aperture in the centre, or this aperture may even be absent in some cases, constituting *imperforate hymen.* This structure is peculiar to the human species, and is never totally absent in the virgin state; but where the hymen ceases to exist, owing to sexual intercourse or other such cause, a few small projecting tubercles *(carunculæ myrtiformes)* mark its ruptured remains. Still tracing the membrane within the canal, its vascularity diminishes, while its surface is marked by transverse folds, which are more numerous inferiorly, and on these are observed the openings of the mucous glands of the vaginæ; two longitudinal folds, *columnæ vaginæ*, are likewise present, on its anterior and posterior walls. The mucous lining having now reached the upper part of the canal, is reflected downwards on the surface of the cervix uteri, and ultimately into the os, becoming here much finer and paler, and at the same time more adherent to the subjacent structures; while by its reflection from the vagina on the neck of the uterus, a circular sulcus is left between those parts, much deeper in front than behind. This membrane appears to be merely an extension of the skin, the epithelium on its surface being squamous or cuneiform, and the secretion has an acid reaction; it is destitute of mucous corpuscles, and in many diseased conditions contains a peculiar animalcule, described by Donne as the trichomonos vaginæ; vibriones are also seen in this secretion, associated, like the former, with puriform exudation.

Bartholinus has called attention to two other glandular bodies, situated on either side of the commencement of the vaginal canal; they are about the size of an almond, of the same oblong shape, and of a yellowish brown colour; each is provided with a separate duct, which opens internal to the mucous folds of the labia minora. Those bodies, are supposed to be the analogues of the glands of Cowper in the male.

INTERNAL FIBROUS LAYER, is much stronger above than below, and very loosely attached to the mucous layer.

ERECTILE LAYER, resembles somewhat in structure the corpus spongiosum urethræ; inferiorly, it is thick and well marked, the veins forming an intricate network on its surface; but superiorly, it

is scarcely visible in the majority of instances; and becomes completely atrophied in old age.

External Fibrous Layer.—Derived from the vesical fascia, is strong and dense below, where it serves to support the vaginal venous plexuses; whilst above, it is incorporated with the cervix uteri.

Dartoid Layer, surrounds the canal, and also connects it to the contiguous organs; it possesses a contractile power analogous to that of the dartos in the scrotum of the male, and assists in the resiliency of the vagina, when that tube has been distended.

In addition to the foregoing the peritonæum constitutes a partial serous investment, on the superior fourth of the posterior surface of the vagina.

Vessels.—The vaginal arteries are two in number, arising from the internal iliac; they course along the sides of the canal, while branches of the vesical, and middle hæmorrhoidal are also distributed to it.

The veins which communicate with the vesical and hæmorrhoidal plexuses, before entering the internal iliac, form, at each side of the vaginal orifice, two large plexiform masses, extending backwards from an inch to an inch and a half; narrow, and pointed anteriorly, but rounded inferiorly; and connected, by the fibrous sheath with which they are invested, to the rami of the pubis, and to the crura clitoridis. Kobelt, who has particularly described them, has termed them the *Bulbi Vestibuli*, and regards them as analogous to the bulb in the male; while he considers the smaller plexuses, which are in front, and continuous with them, as the type of the corpus spongiosum itself; and to these he has given the name of the *Pars Intermedia*.

Nerves.—These are derived from two sources, namely—the sacral plexus of the spinal, and the hypogastric of the sympathetic.

THE FORMATIVE ORGANS.

The Uterus, is of a pyriform figure, situated obliquely in the true pelvis, the base being directed upwards and forwards; and the os, which may be regarded as its apex, downwards and backwards; while the anterior surface, flattened, looks downwards and forwards, and the posterior more convex, upwards and backwards. Its measurement in length, is about two and a half, or three inches; the width at the base, from one inch and a half, to two inches; and the thickness, from three-quarters to an inch. It is divided into a fundus, body, neck, and os, the two latter being contained within the vagina. The os, is bounded before and behind, by two prominent lips, the anterior being the thicker, and the posterior the longer of the two; while the included opening, is circular in the virgin, but

transversely oval in those who have borne many children. Many causes contribute to preserve the uterus *in situ*, and prevent any displacement, namely—the pressure of surrounding parts, the structures closing the outlets of the pelvis, as the rectum, vagina, levatores ani, and coccygeal muscles, with the triangular and sciatic ligaments; and in addition to these, the elasticity of the organ itself, which tends to restore it to its original position, when displaced by temporary pressure. But its ligaments, exercise the most important influence in preserving its relative connexions to the parts which surround it, and these, which are eight in number may be thus enumerated—round, broad or lateral, recto-uterine, and vesico-uterine, each of the two latter being double.

Round Ligaments, two in number, arise from the lateral and superior angle of the uterus, in front of the Fallopian tube they pass upwards, outwards, and forwards, run through the internal ring, and inguinal canal, and then emerging through the external ring are attached to the spine of the pubis; the areolar tissue of which they are composed, with some small nerves and vessels, which they contain, being prolonged down as far as the labia majora. Within the abdomen, a process of peritonæum is continued on the ligament, into the inguinal canal, which often remains pervious as far as the external ring, constituting the *canal of Nuck;* and muscular fibres, which we could only detect for one inch from the uterine extremity, have recently been described on the surface of the ligament, apparently for the purpose, of drawing by their contraction the gravid uterus downwards, into the pelvic cavity; but the ordinary use of the ligaments themselves, is evidently to preserve the uterus in the direct axis of the pelvic cavity.

Broad Ligament.—Are double folds of peritonæum, extending from the lateral and superior angle of the uterus, from the side of that organ, and from the superior part of the vagina on the one hand, to the side of the pelvis on the other. They resemble in some degree a bat's wing when unfolded, and contain between their layers the round ligament most anteriorly, the Fallopian tube in the middle, and the ovary with its ligament behind.

Recto-uterine Ligaments, are constituted by the folds of serous membrane connecting these organs together, and forming the lateral boundaries of the recto-uterine *cul de sac*.

Vesico-uterine Ligaments, are similar in structure to the Recto-uterine, and form the sides of that smaller *cul de sac* which lies between the bladder and uterus. These serous duplicatures are extremely lax, permitting the uterus when enlarged to expand between their layers, without distending the serous membrane.

By now making a section of the uterus vertically, and separating

it into an anterior and posterior half, we will be enabled to observe the form of the cavity which it contains. That of the body and fundus taken together, exhibits a cavity of a triangular form, with the narrower part inferiorly, and the wider portion diverging superiorly and laterally towards the openings of the Fallopian tubes; a slight constriction below, indicated by a circular elevated ridge, defines the line of separation between the body and the cervix. This constriction is named "*os uteri internum*," below which the cervix again expands gradually and again contracts as insensibly, constituting the "os uteri externum."

Coats of the Uterus, are three in number—the most internal, mucous; the middle, muscular; and the external, serous.

Mucous Coat, is thin and fine on the os, but as it ascends into the cervix, it forms a posterior and anterior fold, from which, numerous oblique crests pass off, *arbor vitæ*, on which the glandulæ Nabothi are very copiously distributed; but as it approaches the fundus, it assumes a very different aspect, becoming fine and pale like a serous structure. Still however, although certainly a prolongation from the mucous membrane of the vagina, and possessing a well-marked system of follicles, the continuity which can be traced between it and lining membrane of the Fallopian tube, together with the plastic exudation from its surface which supervenes on conception, would seem to ally it, at least functionally, with the serous tissues; at the menstrual period it becomes highly vascular, but this condition again subsides with the termination of that secretion.

Muscular Coats.—In the unimpregnated organ, muscular fibres are difficult to be detected, but at the third month of utero-gestation, their arrangement can be very well observed, when they are found to consist of a superficial, and a deep set of fibres; the former, which cover the anterior and posterior surfaces of the organ, take a transverse course, but on the sides they follow a curved direction, and appear to be inserted below, into the elastic tissue of the cervix, not abruptly terminating at that point, but continuing into its structure, and intermixing with the elastic fibres observed in this situation; they are likewise prolonged for some distance, on the Fallopian tubes, round ligaments, and ligaments of the ovaries. The deep set of fibres is formed in two hollow cones with their apices superiorly, embracing the orifices of the Fallopian tubes; and their bases inferiorly, meeting by their edges in a raphe on the anterior and posterior surfaces of the body, the fibres all assuming a circular course. In the cervix, the structure is obviously of an elastic nature; although in some cases, we have traced weak and indistinct prolongations of the longitudinal muscular fibres into its tissue, but never in sufficient numbers to affect the general statement, as to the fibro-elastic elements of its composition.

PERITONÆAL COAT.—Covers the body, and fundus, of the organ; but is deficient on the cervix, and os, anteriorly, as well as at those points where the round, and ovarian ligaments, with the Fallopian tubes, are attached.

FALLOPIAN TUBES.—Symmetrical and trumpet shaped, and from three to four inches in length, arise from the superior angles of the sides of the uterus, between the round and ovarian ligaments. They take a direction at first downwards and outwards, and then backwards; each presenting for description two extremities, a uterine and an ovarian; the former commences from the superior angle of the uterus, by an opening capable of admitting a small probe or bristle; while the latter, enfolded in the broad ligament, is dilated and fringed like the tentacula of the polype; of these fimbriæ, one longer, but rarely on the same line with the others, is attached to the capsule of the ovary, whilst the remainder free, twisted on themselves, and floating, have received the name of the *morsus diaboli*.

COATS of the FALLOPIAN TUBES, are three,—an external or serous; a middle or muscular, and an internal, or mucous.

SEROUS COAT, is merely the investment which they receive from the broad ligaments of the uterus, and is always more or less imperfect.

MUSCULAR COAT, consists of a superficial stratum of longitudinal, and a deeper set of circular fibres, both being continued from the uterus.

MUCOUS COAT, pale and fine, presents numerous longitudinal rugæ, the epithelium being ciliated to the point where it becomes continuous with the peritonæum, at the fimbriated extremity of the tube.

OVARIES, are two small oval bodies or glands, situated one in each lateral broad ligament of the uterus, behind and below the Fallopian tubes; their length being in the virgin about one inch and a half, their breadth three quarters, and their thickness half-an-inch; but in advanced life, and even at the age of forty, if the female has borne many children, the difference in size and weight is very remarkable; in the virgin being from ninety to one hundred grains, and in the multiparient from forty to fifty. These glands are convex on all their aspects, except the inferior which is slightly concave, and are covered by a serous membrane, but otherwise unattached; the inferior edge is notched, for the entrance and exit of vessels, receiving externally the attachment of the Fallopian fimbria, while it is fixed internally by the ligament of the ovary. *The ovarian ligament* appears as a strong round cord, connected externally to the ovary, where it becomes expanded and mixed with the fibrous stroma of the gland, and inserted internally into the side and superior angle of the uterus. In the fœtus the ovaries are in the lumbar region, but after birth assume

their position in the true pelvis; during pregnancy, they follow the uterus into the abdominal cavity, and after parturition remain for some time in the iliac fossæ; occasionally, they become displaced into the recto-uterine *cul de sac*, where their existence can be detected by the introduction of the finger through the rectum.

Structure.—The first covering, or the *indusium,* is derived from the peritonæum; the second, or *tunica albuginea,* is condensed fibrous tissue, and is deficient at the hylus, where the nerves and vessels enter the organ, while the parenchymatous tissue called the *stroma,* consists of a pale vascular structure which separates and connects the ovisacs, and is permeated in all directions by a vascular network. Each ovary contains innumerable Graafian vesicles, or ovisacs, the larger being found nearest to the surface; these cells of the ovary have two coats, the first being a dense but vascular capsule, lined internally by a granular membrane, the cavity being occupied by a granular fluid, containing a few oily particles, together with the ovum, which appears as a small transparent vesicle, about 1-120th of an inch in diameter, attached to the inner surface of the Graafian ovisac by retinacula, or the proligerous disc, and covered by a granular layer (tunica granulosa). The ovum possesses a dense but transparent envelope that surrounds the yelk, being named *zona pellucida* (Valentin), or *chorion* (Wagner), and in its centre is found the germinal vesicle (Purkinje), with the macula germinativa (Wagner). These several parts are subject to changes or modifications, in the progress of generation, which will be briefly described hereafter.

VASCULAR SUPPLY of the INTERNAL ORGANS.—The uterus receives its vessels from several sources, namely,—uterine branches of the internal iliac, vesical in front, and the middle hæmorrhoidal posteriorly; and lastly, a few twigs from the spermatic arteries.

The VEINS, are numerous and large, opening into the internal iliac, and communicating with the hæmorrhoidal, and vesical plexus.

The LYMPHATICS, consist of a superficial, and a deep set; the former being the more numerous; they join the pelvic, and lumbar lymphatic glands.

The NERVES of the UTERUS, are branches of the sacral, and hypogastric plexuses of the sympathetic; the former, appearing to preside over the reflex motor influences; and the latter, subserving to the special generative functions of the uterus, as also associating it not only with the other parts of the urino-genital apparatus, but likewise with more distant organs.

VASCULAR SUPPLY of the OVARIES.—The spermatic arteries not only supply these glands, but also send branches to the uterus.

NERVOUS SUPPLY.—This is derived from the hypogastric plexus. The VEINS ascend on the psoas muscle, and form a tortuous inter-

lacement, *corpus pampiniforme*, the right terminating in the vena cava inferior, the left in the corresponding renal vein.

The Uterus presents some peculiarities as an organ, exclusive of the special functions which it is called on to perform; amongst these are its quiescence until the period of parturition arrives, its rapid enlargement in so brief a period, from two or three ounces to the enormous weight of four pounds and a half, so that during the distention of the organ it undergoes an absolute increase in thickness of its walls, which although in some measure attributable to the enlargement of its vessels, the arteries becoming large and tortuous, and its veins so dilated as to resemble sinuses, which adhere to the proper tissue of the organ, is likewise due to an actual hypertrophy of the uterine muscular fibres, which is proved by the circumstance that the organ does not contract to its exact original magnitude, until some time after parturition has been accomplished.

The functional action, of the several organs described, may thus be briefly stated :—

The Spermatozoa, introduced into the vagina, enter the uterus in virtue of their automatic movements, and pass through that cavity, and the Fallopian tubes, urged in that direction by the ciliary appendages of the epithelial investments, till they reach the ovary, where their existence was demonstrated by the Abbatè Spallanzani. The vascularity of the ovary now increases, an elevation appears on its surface, and the Fallopian tube firmly grasping its capsule, the ovum escapes into the tube, by a slit or rent in the peritoneal investment; this escape is caused by the thickening of the granulary membrane, with a coincident increase in the granulary fluid, accompanied with absorption of the capsule, and assisted by the compression of the fimbriated extremity of the Fallopian tube. In the tube, the ovum receives an albuminous covering, *chorion*; and then slowly pursues its course towards the uterus, urged in that direction by the ciliary wave, and the vermicular action of the tube; but whilst these changes are taking place in the ovaria, and their appendages, the uterus also participates in the functional activity; the glands at the cervix, throw out an albuminous matter which seals the outlet of the uterus, *operculum*; while the lining membrane of the body and fundus become vascular, and the follicles prominent; a plastic membrane, *decidua vera*, is now effused, which lines the entire surface; and the ovum then, entering the cavity, pushes the decidua vera before it, receiving from that membrane a surface covering, *decidua reflexa*, Hunter; whilst a fluid, *hydroperion*, is elaborated between the two layers, which constitutes the nutritive material for the fœtus, in its early stages of uterine life. Mr. Goodsir has, however, offered a different explanation of the formation of the

decidua: according to him, the vera is derived from the interfollicular spaces; whilst the reflexa, being a cell-structure, is secreted by the uterine follicles themselves; the placenta being formed in a subsequent stage, where a new series of changes results (for which see Fœtal Circulation).

When the ovum leaves the ovary, the ovisac remains filled by the thickened granulary membrane and blood, including a cavity in the recent state, but subsequently becoming of a yellow colour, striated but friable, like a lobule of a salivary gland, *corpus luteum.* The cicatrices of small abscesses, or scrofulous tubercles, may sometimes be confounded with true corpora lutea (Montgomery) but the former cannot be injected.

URINARY ORGAN IN THE FEMALE.

The Bladder resembles in shape, that of the male, but is larger in size, and much broader in its transverse diameter. It lies immediately behind the symphysis pubis, and is separated from the promontory of the sacrum by the uterus, which acts as a cushion, and preserves it from rupture, an accident to which the male organ is often liable, from striking directly against that point of bone, with no protecting structure intervening. It rests, not on the rectum, but on the anterior wall of the vagina, and neck of the uterus.

Urethra.—In the normal state, a very narrow membranous canal, about an inch and a half in length, running from the bladder above, to the *meatus urinarius* below. Like that of the male, it perforates the triangular ligaments, where it is surrounded by the compressores urethræ; having passed obliquely between the coats of the anterior wall of the vagina. It is slightly curved, with the concavity looking upwards and forwards.

Coats of the urethra are three in number—muscular, spongy, and mucous.

Muscular Coat consists of pale white fibres, better marked below than above.

Spongy Coat similar to the corpus spongiosum in the male. It completely surrounds the canal; but is always more or less intermixed with the muscular coat.

Mucous Coat is disposed in longitudinal folds; and is sparingly studded throughout its whole extent, with a few mucous crypts, for the purpose of lubrication. The urinary organs of the female, do not appear to be possessed of the same amount of acute sensibility, as distinguishes those of the male; the same remark being equally applicable to the rectum of both sexes, as the one can bear an amount of distension, absolutely incapable of being tolerated by the other.

Mammae, or Mammary Glands.—Those organs are situated on the anterior and upper part of the thorax, corresponding to the space included between the second and seventh ribs. Each gland is oval in its outline, and irregular at the margin, with the long measurement directed downwards and inwards; its anterior surface convex, is surmounted by the nipple; while the posterior concave, rests on the great pectoral muscle. The structures composing the organ are :—1. Skin; 2. Sepimenta, and capsule; 3. Fat; 4. Lactiferous tubes, erectile tissue, nerves, vessels, and absorbents.

The skin on the surface of the breast is fine, soft, and smooth, but immediately surrounding the nipple it becomes of a dark colour, particularly in the pregnant female, where it constitutes the *areola*, presenting in this situation numerous sebaceous glands, with a few prominent papillæ, and fine hairs in the old subject; as it approaches the nipple its tenuity becomes well marked, and at the free extremity of that prominence it is continuous with the mucous lining of the lactiferous tubes.

The capsule, is formed by the superficial thoracic fascia, which splits at the upper margin of the organ to enclose it, while it likewise sends processes, *ligamenta suspensoria*, into its structure, to separate and connect the lobules of which the organ is composed.

The fatty tissue, is the predominating structure, and forms the principal volume of the breast in the infant, when it is comparatively large, as well as in the adult; but in old age, both the fat and the glandular tissue undergo the process of absorption, producing senile atrophy; but occasionally however, the reverse is the case with regard to the fatty tissue, its volume becoming greatly augmented, so that the gland may attain the weight of several pounds.

The *lactiferous tubules*, commence by cœcal extremities or loops from the margin of the gland, and a number of these coalescing, form a lobule, which is perfectly isolated by the sepimenta of the capsule; a single duct, the efferent tube of each lobule, approaches the base of the nipple, where it is dilated into an ampulla; the latter are from twelve to sixteen in number, from each of which a small duct passes through the nipple, to terminate at its free extremity.

The nipple, is situated at the most convex part of the breast, and is variable as to size and figure, being small, conical, and smooth in the virgin, but long and enlarged at the extremity during the period of lactation. It may, however, be extremely elongated; or, on the contrary, so small and deeply sunk, that the infant may be unable to grasp it. In colour it varies from a light pink to a dark red; and at the extremity presents two or three depressions, on which the lactiferous tubes open. Its structure consists of a fine but closely

adherent tegumentary investment, inclosing a cylinder of dense erectile tissue, with the efferent tubes of the gland.

VASCULAR SUPPLY.—Is derived from the long thoracic, intercostal, and internal mammary arteries. The veins of the organ open into the internal mammary, and the axillary.

NERVES.—Are branches from the third, fourth, fifth, and sixth intercostal, together with filaments from the thoracic branch of the brachial plexus.

The breast, the organ for the secretion of milk, is not fully developed until puberty; but still it is very constant in its presence, cases of total absence being unrecorded; but, on the other hand, the number may be augmented to four, as in a case recorded by Mr. Shannon, surgeon to the South Union Hospital, in the *Dublin Quarterly Journal of Medical Science;* in that case the supernumerary organs secreted with the same freedom as those occupying the normal position. As conglomerate glands, their structure is exceedingly complex—a circumstance that would scarcely be expected, when it is remembered that milk may be vicariously secreted by the mucous membrane and skin; and also, that the fluid is found in the blood, as pregnancy approaches its termination, from which it might be inferred that the glands are merely outlets for the secretion.

COMPOSITION OF MILK.

Organic—Human.

Water,	88·06
Caseine,	3·70
Sugar,	4·54
Butter,	3.40
Salts, Extractive,	0·30 (Simon.)

Inorganic—Cow.

Chloride of sodium,	0·024
" potassium,	0·144
Soda,"	0·042
Phosphate of lime,	0·231
" magnesia,	0·042
" peroxide of iron,	0·007 (Haidlen.)

FEMORAL HERNIA.

The extremity should now be raised on a block to a convenient height, and an incision made from the anterior superior spine of the ilium, along the outer side of the thigh, for about six inches, and another from the symphisis pubis, along the inner side for the same

length; those incisions should now be connected below by a transverse one, and the flap raised from below, upwards. The superficial fascia in this region is strong externally, and loaded with fat in the infant and female, but firm and frequently strengthened by aponeurotic bands in the male adult; it consists of two laminæ of unequal density, separated by lymphatic glands, and the three superficial branches of the femoral artery, with their corresponding veins—viz., external pudic, external circumflex ilii, and superficial epigastric, which have been already described with the superficial investments of the abdomen. The short saphenous nerve, or branch of the anterior crural, may be also observed, about an inch and a half below Poupart's ligament, as well as the crural branch of the genito-crural nerve, the branches of which are seen descending to the middle third of the thigh. To the outer side and half an inch below the spine of the ilium, the musculo-cutaneous nerve, derived from the the lumbar plexus, is brought into view, one branch passing backwards to the gluteal region; and the other descending, on the anterior and external side of the thigh.

The inguinal glands, consist of two sets, a superficial, and a deep; the former, five or six in number, lying between the layers of the superficial fascia, some of them running parallel to Poupart's ligament, and others, being either above it, on it, or below it; while two or three are vertical in their direction and in close proximity to the internal saphenous vein, one being always situated at its entrance into the saphenic opening, and may when enlarged simulate femoral hernia; the deep, are parallel to, and on the internal side of the femoral vein, and are variable both in size and number, the most trifling causes sometimes producing their most rapid enlargement.

The internal saphenous vein, also appears through the fascia, the superficial portion of which should be cleaned to the point where it sinks deeply above; this large cutaneous vein, commencing on the dorsum of the foot, from the internal extremity of the tarsal arch, ascends in front of the internal malleolus, on the inner side of the leg, over the gastrocnemius, and passing internal and posterior to the internal condyle of the femur, continues its course upwards, on the vastus internus, and adductor longus, but separated from them by the fascia lata; about one inch and a quarter below Poupart's ligament, it arches outwards and backwards, perforates the cribriform fascia, and runs through the saphenic opening, to terminate in the femoral vein. In its course upwards, it receives the internal, and posterior cutaneous vein of the thigh; while the venæ comites of the superficial epigastric, pudic, and circumflex, having previously united with each other, also open into the convexity of its curve superiorly. (See VENOUS SYSTEM.)

Fascia Lata of Thigh.—On removing the superficial fascia, with the several vessels, and nerves just described, this structure is seen; but in order, to understand properly its peculiar arrangement, the saphenous vein should be cut across, about six inches below Poupart's ligament, and its superior part carefully dissected upwards towards the abdominal wall, when the sapheuic opening, through which it enters, will be fully exposed. The fascia lata, is divided into three portions—iliac, pubic, and cribriform; of these the iliac is the most external, and the strongest, as well as the most anterior; it is attached above, to the crest of the ilium, and the lower edge of Poupart's ligament, as far inwards as the base of Gimbernat's; its internal edge is lunated, and forms the falciform process of the fascia lata, the concavity of which looks downwards and inwards, and is divided into a superior cornu (Hey's ligament), and an inferior cornu (Burn's ligament), with an intervening edge between them. The superior cornu is of variable strength, being thick in the male adult; but thin, and often separated into bands, in the female and child. It is attached superiorly to Poupart's ligament, at the internal fifth of which, it divides into two processes: one superficial, and thin, is prolonged downwards and inwards, on the pubic portion of the fascia lata (Colles's ligament, see *Flood on Hernia*); while the other, stronger, dips backwards, and is attached to the linea ilio-pectinea and base of Gimbernat's ligament (Hey), lying in front of, and internal to the femoral ring; the inferior cornu, is sharp and well defined, blending insensibly with the pubic portion to form the saphenic opening, the whole arch being described by some authors as constituting the saphenic aperture, but improperly, as it is much better to restrict the term to the inferior part only, or that formed by the junction of Burn's ligament with the pubic division; the shape of this portion is crescentic, with the concavity directed upwards and slightly inwards, its lunated margin being prolonged backwards on the saphena vein to become continuous with the sheath of the femoral vessels; but still when the vein is raised from its position, the handle of the scalpel can be passed between this inflexion from the saphenic opening, and the sheath, for about two lines, and occasionally for fully half an inch.

The pubic portion of the fascia lata is much thinner than the iliac, and lies on a plane posterior to it; it is attached to the rami of the ischium, and pubis; and to the symphysis, and linea ilio-pectinea, where it becomes continuous with the superior cornu of the falciform process; externally, it passes outwards over the adductors, and beneath the femoral vessels, which should be removed in order to see it, and at the margin of the psoas splits into two layers, one of which, the superficial, runs in front of that muscle, and, ascending on its

surface, becomes continuous, at the pectineal line, with the fascia iliaca, from which a process descends to form the posterior part of the sheath of the vessels; while the second or deeper layer passes behind the psoas tendon, and is attached to the capsule of the hip-joint, where it constitutes the pubio-femoral ligament, and covers the bursa in this situation. At the saphenic opening however, the pubic fascia does not split, but at this point, or fourteen lines below Poupart's ligament, joins the iliac division, and assists in completing the crescentic aperture. The middle portion, naturally left between those two fasciæ, that is, between the iliac and pubic portions, is the cribriform, which is more weak, cellular, and fatty than the others, and is continued upwards, as Scarpa's layer, on the abdomen, its superficial surface being blended with the subcutaneous layer of that region; below Poupart's ligament, to which it is closely connected, it is pierced by the superficial branches of the femoral artery and short saphenous nerve, together with the internal saphena vein, and from the sieve-like appearance, which those perforations produce, the name cribriform is derived. In all cases, it can easily be raised from the pubic portion; but when an attempt is made to detach it from the iliac division, a direct continuity is observed between them; a circumstance, which did not escape the acute observation of the late Mr. Colles; and therefore, any attempt at definition of the falciform process, can only be considered as artificial. When examined in fat subjects, it is found to be thick, and loaded with adeps; but in the thin and emaciated, it partakes of the laminated structure of the iliac portion, being loosely attached to the superficial fascia, but intimately to the sheath of the femoral vessels which lies beneath it.

Crural Arch.—It would now facilitate the examination of this intricate subject, if the parts passing beneath the crural arch were dissected on the opposite side; for this purpose the fascia lata should be removed from Poupart's ligament, the fascia iliaca raised from the muscle of that name; and the external iliac artery, and vein cleaned from their peritoneal, and fascial investments. The crural arch is all that space included between Poupart's ligament in front, and the bone posteriorly; and is somewhat triangular in shape, with the base externally, and the apex internally, at Gimbernat's ligament. The parts passing beneath it, from without inwards, are the following – most externally, the external or musculo-cutaneous nerve, with the origin of the sartorius; next in order, the iliacus internus, with the anterior crural nerve; then the psoas magnus, and the outer wall of the sheath of the vessels, or external septum crurale; next the femoral artery, the middle septum, the femoral vein, internal septum crurale; the femoral ring filled by a gland, through which pass the deep lymphatics; the crural branch of the genito-crural

nerve; and lastly Gimbernat's ligament, with Hey's attached to its base.

From what has been just stated, it is quite evident that the communication between the abdominal cavity and the upper part of the thigh, in other words, the crural arch, is completely filled up by the several solid parts passing through it, with one exception only, and that is the aperture known as *the crural or femoral ring*. This opening imperfectly occluded by a gland, through which the Lymphatics pass in their course upwards, is of very variable size, but generally large enough to allow the point of the forefinger to be pressed through it; it is of a triangular shape, with its base directed outwards, corresponding to the femoral vein, and internal septum crurale; and its apex, which is truncated, directed inwards, constituted by the base of Gimbernat's, and Hey's ligaments; its anterior leg is formed by Poupart's ligament, and the parts attached to it; and its posterior, by the linea ilio-pectinea, and the origin of the pectineus muscle. In the inclined plane stretching from the anterior superior spine of the ilium to the spine of the pubis, the ring occupies, in the erect position, the most depending point, and hence it follows, that in a threatened hernia, the gut always naturally selects this part, in order to escape.

The cavity of the abdomen with its lining fasciæ has not been inaptly compared to a funnel with two nozzles, the latter being represented by prismatic tubes, known as the crural canals, which communicate on each side, through the medium of the rings, with the funnel above. But in order to understand those several parts thoroughly, it will be necessary to take a review of the fasciæ of the abdomen, as without clearly comprehending their complicated arrangement, it is utterly impossible to acquire a clear idea of the anatomical details of a femoral rupture. Before, however, proceeding to do so, it will be necessary to examine the subperitonæal areolar tissue in those regions, and this may be effected by tearing the cœcum from its attachments on the right side, as well as the peritonæum, taking care to observe the lax areolar tissue connecting the intestine to the subjacent fascia, which is sometimes the seat of ileo-cœcal abscess; but on the left, on raising the sigmoid flexure of the colon, which occupies only the superior part of the fossa, and the peritonæum, which invests it, the areolar tissue will be found to be more dense, smaller in quantity, and less subject to abscess. The external iliac vessels are now seen covered by a thin fascia, and on their external and anterior part, the genito-crural nerve is observed, as well as the musculo-cutaneus, which is sometimes double, from having divided before leaving the pelvis, running obliquely forwards and outwards, towards the anterior spine of the ilium. The thin fascia alluded to

as constituting the sheath of the iliac vessels, is evidently a condensation of the subperitoneal areolar tissue, although described as a process of the iliac fascia by Abernethy, which is certainly incorrect; it covers and adheres to the artery and vein, sending also a thin septum between them, which separates while at the same time it connects them to each other. On tracing this fascia downwards on the forepart of the vessels to Poupart's ligament, it becomes lax, and often divisible into two or more layers, which are lost above and in front, on the deep surface of the fascia transversalis, between it and the peritonæum; from this point it passes downwards and backwards, to become continuous with the pelvic fascia below, crossing in its descent, and thus closing the posterior aspect of the femoral ring, and necessarily forming the fascia propria for a hernia occurring in this region. This view likewise accords with that of Cloquet, or very nearly so, who is inclined to regard the fascia propria as a structure distinct from the fascia iliaca, which we will now proceed to examine.

Fascia Iliaca, seen on removing the last, is attached to the internal lip of the crest of the ilium; to the ilio-lumbar ligament, from which it stretches upwards, as high as the ligamentum arcuatum verum, to form the sheath of the psoas; and to the posterior margin of Poupart's ligament, as far inwards as the outer edge of the external iliac artery, being here continuous with the fascia transversalis, a dense white line parallel to Poupart's ligament indicating their junction, and forming by their union a fibrous canal, in which is found the internal circumflex ilii artery, accompanied by one or two veins; on reaching the external iliac artery, the fascia dips backwards, constituting, as it does so, the external septum crurale, then passes beneath the artery, and over the psoas, behind which it sends a thin layer, and at last becomes attached to the linea ileo-pectinea, as far inwards as the base of Gimbernat's ligament, where it becomes continuous with the pubic portion of the fascia lata: a layer from the union of the two, being also sent downwards into the thigh, to form the posterior part of the sheath of the vessels, the anterior, as we shall presently see, being derived from a similar process of the fascia transversalis.

Fascia Transversalis, has been already described in connection with inguinal hernia; here, therefore, it will be only necessary to observe that it is attached inferiorly and externally, to the inner lip of the crest of the ilium, and to Poupart's ligament in close connection with the fascia iliaca, as far in, as the outer edge of the external iliac artery; at this point, as already stated, the two fasciæ again separate from each other, the fascia iliaca dipping backwards, behind the vessels, to be attached to the linea ileo-pectinea; while the fascia transversalis continues its course inwards, still con-

nected to Poupart's ligament, until it reaches the middle line, where it unites with its fellow of the opposite side. But as it passes over the artery and vein, it sends between them a strong process (middle septum crurale) which is blended posteriorly with the fascia iliaca ; and more internally, another with similar attachments, between the latter vessel and femoral ring (septum crurale internum). From this description therefore, it would appear scarcely possible, that a hernia could protrude through any portion of the space intercepted between the anterior superior spinous process of the ilium and the last named structure; but gliding downwards and inwards towards the ring, it escapes through this outlet, which, owing to peculiar circumstances, must always present certain characters of weakness that will ultimately yield to long-continued and sustained pressure from above, and having once transgressed the limits of this opening, it enters at once within the walls of the crural canal—a space which we will now proceed to describe, in conjunction with the sheath of the femoral vessels.

Sheath of the Femoral Vessels.—By dividing the superior cornu of the iliac portion of the fascia, from Poupart's ligament, and reflecting it outwards, *the femoral sheath*, which is a funnel-shaped tube, larger above than below, and prolonged superiorly from the iliac and transverse fasciæ, may be examined; it is strong, and well marked, as far as the saphenic opening ; but can be traced as a distinct structure to the end of Hunter's canal, where it is lost in a strong adherent process which surrounds the vessels below. Above, it contains three distinct canals separated from each other by two septa, sent backwards from the transversalis fascia, to join the iliac ; the external canal, containing the artery ; the middle, which is much the largest, the vein ; and the internal, the smallest, giving passage to the deep lymphatics. To the last has been assigned the name of the "crural canal," and as the anatomy of femoral hernia can never be properly understood without a full acquaintance with the mode of formation of this space, we will now proceed to describe it in detail. The crural canal, may be considered as a patulous three-sided cone, with the base above, at the femoral ring, which forms in fact its superior aperture; and its apex below, at the saphenic opening; it is about one inch and a quarter in length, and its boundaries are :—anteriorly, fascia transversalis, or anterior wall of the sheath—posteriorly, fascia iliaca, or posterior wall of the same—internally, the junction of those two fasciæ ; and externally, the septum crurale internum—in other words, a hernia in its first descent, is as distinctly within the walls of the sheath as the vessels themselves. By assuming this fact at once, every difficulty is immediately cleared away, and the whole becomes per-

fectly intelligible. The septum separating the venous, and lymphatic canals is exceedingly strong; and that which divides the artery and vein is also well marked, particularly in old subjects where the former vessel is diseased. A transverse section of the sheath, about a quarter of an inch below Poupart's ligament, exhibits very well the arrangement of this structure, as it displays clearly the artery, vein, and lymphatic gland, each occupying its separate compartment. The occurrence of a femoral hernia, between the anterior spine of the ilium, and the external iliac artery, is prevented by the junction of the iliac and transverse fasciæ, forming, as we have already observed, an almost insuperable barrier against such a protrusion; it rarely occurs in front of the femoral vessels, owing to the upward reflection of Abernethy's fascia, and the mode in which these vessels are wedged beneath Poupart's ligament, and retained in position by the several septa; while Gimbernat's ligament obviates any protrusion internal to the ring, as a general rule; although it is necessary to be aware, that hernia may, and has occurred in the three situations alluded to; but these are merely exceptional cases. At the femoral ring, there is however, less resistance than in any other part of the crural arch; and the intestine, or omentum, having passed through the ring, presses before it the peritonæum as its sac; and also Abernethy's fascia, as its fascia propria herniæ; it then descends in the sheath of the vessels, separated from the vein by the internal septum crurale, which prevents injurious pressure on that vessel. Whilst in this position, or immediately below Poupart's ligament, the coverings are the following:—1. Integument; 2. Superficial fascia; 3. Cribriform fascia; 4. Anterior layer of the sheath; 5. Fascia propria; and 6. the Peritoneal sac. But, the pressure still continuing to operate in a direction from above, the intestine descends until it reaches the saphenic opening; beyond this, it cannot pass within the lymphatic sheath, as the latter terminates at the entrance of the saphena into the femoral vein; it consequently is arrested temporarily at this point, until, on receiving some fresh impetus from above, it bursts through the anterior layer of the sheath, but is again prevented from passing downwards, beneath the fascia lata, in consequence of the process which is sent backwards from the margin of the saphenic opening on the femoral sheath; it therefore forces a passage through the cribriform fascia, when its further descent in this direction is arrested according to some, by its becoming implicated in the loop of the superficial epigastric artery, which, as it ascends towards Poupart's ligament forms a curve, with the concavity directed upwards; while, according to others, its course downwards or outwards, cannot take place, owing to the close adhesion of the superficial fascia to the edge of the saphenic opening and falciform

process; it therefore must seek the position where least resistance is offered to its progress, and where the fasciæ are easily capable of separation; this is found in that natural groove, or depression that exists between the femoral vessels externally, and the adductor longus internally. Through this, it winds upwards, over Pourpart's ligament, and on reaching the abdominal wall, lies between Scarpa's, and the superficial fascia, its coverings being, from superficial to deep; integuments, superficial fascia, fascia propria, and the peritoneal sac. In the course just described, the intestine may be strangulated at any of the following points :—by the orifice in the cribriform fascia, by Burns', Hey's, by Gimbernat's ligaments; or contraction of the neck of the sac, or by bridles of lymph crossing the cavity. In the reduction of a fully formed femoral hernia, it will first be necessary to relax the abdominal walls, by placing the patient in a partially sitting position, and also by flexion and inversion of the thigh, to relax Poupart's ligament, by acting on the iliac portion of the fascia lata; the tumour should then be pressed downwards, then backwards, and finally forced upwards, backwards, and outwards, in the direction of the crural canal. In the operation for strangulated femoral hernia, after the sac is opened, and the finger introduced to the stricture, the latter should be divided upwards and inwards, many authorities conceiving it sufficient to divide Hey's ligament, where it dips backwards, to join the base of Gimbernat's. In this case, the obturator artery may be wounded, if it arise from the internal epigastric; instead of taking its ordinary origin from the internal iliac; as in this anomalous instance it usually passes internal and anterior to the neck of the sac, but even with this origin it may run behind the neck, and thus be removed from all danger (see ANATOMY of the ARTERIES). Or, again, the edge of the knife may be directed upwards, forwards, and inwards, so as to divide Colles' ligament, or directly upwards and forwards, so as to cut Poupart's; but in the latter instance, great care must be observed not to injure the vas deferens in the male; and in both sexes, this mode of operation is very apt to be attended with permanent weakness to the abdominal walls, and should therefore be seldom adopted. The knife may be also turned downwards and outwards, so as to divide Burn's ligament; or directly outwards, so as to incise the falciform process; or, in fact, it may be stated, as a general rule, that the slightest cut in any one of those positions alluded to will be quite sufficient, in the great majority of instances, to relax all the constricting tissues. The femoral form of hernia, is much more frequent in the female, than in the male; because the crural arch is wider, the fasciæ weaker, and the muscles which naturally occupy the space, are smaller. On the other hand, the abdominal rings are

smaller in the female, thus obviating the tendency to inguinal protrusion.

GLUTÆAL REGION.

In order to examine this region, place a block beneath the pelvis, to make the parts tense; carry an incision round the crest of the ilium, from the posterior spinous process downwards, on the side of the sacrum to the coccyx, and then let it be continued obliquely downwards and outwards, to the junction of the upper and middle thirds of the femur. The skin is thick and dense in this region, particularly over the tuber ischii, and is supported by a fatty subcutaneous areolar tissue, usually described as the superficial fascia; anteriorly and superiorly, it partakes somewhat of the characters of that structure; but inferiorly, where it forms the fold of the buttock, the fatty granules constitute a thick elastic mass, sustained and kept in position by dense bands of areolo-fibrous tissue, which preclude displacement of the adipose mass, during the sitting posture. In this layer, over the buttock several cutaneous nerves are exposed: thus, most anteriorly, we find a twig sent back from the musculo-cutaneous, a branch of the lumbar plexus; more posteriorly, the external branch of the last dorsal nerve, which, having pierced the transversalis, internal and external oblique muscles, turns over the crest of the ilium, and also terminates in the integument; still further backwards, the iliac branch of the ilio-scrotal crosses the crest of the ilium, and, bending downwards, supplies the skin; still nearer the sacrum, some cutaneous filaments are visible, derived from the lumbar nerves; and inferiorly, a cutaneous flat filament from the lesser sciatic, winds round the lower edge of the glutæus maximus, and is lost about the centre of the region. Those numerous cutaneous nerves, account for the exquisite sensibility which is manifested in those hysterical affections simulating hip-joint disease, which have so repeatedly led the most experienced surgeons into an error of diagnosis.

Glutæal Fascia.—On removing the fat, the proper fascia is exposed, strong in front but weak posteriorly; it passes from the tensor vaginæ, over the glutæus medius, where it is tense and remarkably thick; and arriving at the anterior margin of the glutæus maximus, splits into two layers, one of which passes superficial to, and the other deeper than that muscle; the superficial, is attached to the crest of the ilium, and to the spines of the sacrum; while the deep, weaker in its character, runs beneath the muscle, and adheres to the glutæus medius, and capsular muscles; it is attached behind, to the great sciatic ligament; and covers the glutæal vessels, sending tubules on

them, and so confounding them with the surrounding parts, that they are with difficulty isolated. This fascia may now be raised, in a line from the sacrum to the great trochanter, and the glutæus maximus exposed.

Glutæus Maximus.—Somewhat square in shape, and placed on the buttock and superior fifth of the thigh, arises from a triangular surface on the posterior fifth of the crest of the ilium, from a depression below it, from the side and back of the fifth piece of the sacrum, also from the coccyx, from the sheath of the erector spinæ, posterior sacro-iliac, ilio-lumbar, and great sacro-sciatic ligaments; the fibres pass obliquely downwards, outwards, and forwards, and become attached to a broad aponeurotic expansion, which is inserted into the fascia lata, into the line leading from the great trochanter to the linea aspera, and into the upper third of that line, between the vastus externus and the adductor magnus, and above the origin of the short head of the biceps.

Relations.—It is covered superficially by the skin, fat, and fascia; and lies on parts which will be enumerated, when it is cut across and reflected. In structure it is coarse and fasciculated, in this respect strongly resembling the deltoid; the superior two-thirds of the fibres are connected to the bone, but the inferior are attached to the fascia, covering the vastus externus. Of the four margins, one is connected to the sacrum; a second, anteriorly overlaps the glutæus medius; a third, thick and round, forms inferiorly the fold of the nates; and the fourth, is aponeurotic and attached to the femur. In morbus coxæ this muscle is atrophied.

Action.—To extend the thigh, rotate it outwards, and preserve the erect position of the body; for this last purpose being much better developed in man, than in the lower animals. It is also, of great use in supporting the posterior surface of the articulation.

If the muscle be now cut across and reflected, and the thin layer of fascia removed from the parts beneath, the following will be brought into view:—glutæus medius, but its anterior fourth, is still covered by a strong fascia; and at its lower margin the glutæal artery, and vein, superior glutæal nerve, all of which separate it from the pyriformis, as the latter runs outwards to emerge from the great sciatic notch; below the pyriformis, the sciatic, and pudic arteries and veins; the pudic, greater, and lesser sciatic nerves, and the inferior glutæal when arising from the sacral plexus, and not from the lesser sciatic; then, the superior gemellus; beneath it, the tendon of the obturator internus, inferior gemellus, tendon of obturator externus, covered by the quadratus femoris; then, the transverse fibres of the adductor magnus, separated from the last named muscle by the terminal branch of the internal circumflex of the profunda, and also

when the thigh is inverted by the lesser trochanter, and the insertion of the psoas, and iliacus muscles; still lower, the great sciatic ligament is exposed, with the tuber ischii, the origins of the hamstring muscles, the great trochanter, and the bursa which covers that point of bone. This bursa is extremely large and multilocular, with one surface adhering to the bone, and the other to the deep aspect of the muscle; but another smaller one, is often found between the tuber ischii and the muscle; and sometimes even a third between its tendon and the vastus externus. In one instance, the three bursal sacs were observed to form a continuous chain, a free communication existing between them, but the rule is that each should be distinct. We have also, in three cases, seen a bursa between the tendon of the muscle where it commences, and the superficial fascia.

Glutæus Medius.—Triangular in shape, thick and fleshy above, but narrow and tendinous below; arises from the superior curved line on the dorsum of the ilium, from the surface above and below that line, from the three anterior fourths of the erest of the ilium, anterior superior spine, and notch below it, from the strong fascia which eovers its anterior fourth, and frequently tendinous from the anterior point of the inferior curved line; the anterior fibres pass downwards and backwards, the posterior downwards and forwards, the middle vertically, and are all inserted by a fan-shaped tendon, which is formed within the muscle, into an oblique facette on the external side of the great trochanter, and into a tubercle at the anterior part of that facette.

Relations.—It is covered by the glutæus maximus, tensor vaginæ femoris, and in front by the fascia only; also by the superficial branches of the glutæal artery, and a thin fibrous layer. It lies on the glutæus minimus, on the deep branches of the glutæal artery and nerve, and on the ilium and great trochanter, from the upper part of which it is separated by a bursa.

Action.—The anterior fibres flex and rotate inwards; while the posterior extend and rotate outwards, the anterior being much the more powerful; the whole muscle will abduct the limb, and strengthen the capsular ligament externally.

Glutæus Minimus, seen by reflecting the last muscle, to which it is similar in shape, but much smaller; arises from the inferior curved line on the dorsum of the ilium, and from the capsular ligament of the hip-joint; the anterior fibres pass downwards and backwards, the posterior obliquely forwards, the middle vertically, and are attached to a fan-shaped tendon, which is inserted into the upper and anterior part of the great trochanter, the bone being here usually marked by a facette, which is transverse in its direction.

Relations.—It lies on the bone, external tendon of the rectus

femoris, and capsular ligament of the joint, with some adipose areolar tissue intervening. It is covered by the glutæus medius, with which it is united anteriorly; and by the deep branches of the glutæal artery and superior glutæal nerve; the tendon is generally united with that of the pyriformis.

Action.—Similar to the last, but that it abducts more forcibly, and in that motion draws the synovial membrane out of the articulation. (See Glutæal Artery, in the Anatomy of the Vessels, also the Glutæal Nerve, a branch derived from the lumbar plexus.)

Pyriformis.—Triangular or conoid in figure, and lying partly within, and partly without the pelvis, wide and fleshy at its origin, but narrow and tendinous at its insertion; arises by fleshy slips from the second, third, and fourth bones of the sacrum, between the gutters of the anterior sacral foramina. It is at first, flat and fleshy, and as it passes outwards through the sciatic notch, takes an origin from its upper margin, and also from the sciatic ligament; the fibres, external to the pelvis, converge and terminate in a tendon, which passes downwards, outwards, and forwards, and is inserted into the inner side of the great trochanter, above the digital fossa, and below the glutæus minimus, with the tendon of which it is sometimes intimately blended.

Relations.—Anteriorly it is covered, while within the pelvis, by the sacral plexus, branches of the internal iliac artery, and the rectum on the left side; but outside the pelvis, the anterior surface corresponds to the bone and a part of the capsular ligament; the posterior surface within the pelvis lies on the bone, and, outside that cavity, is covered by the glutæus maximus and descending branches of the glutæal artery; above, it corresponds to the glutæus minimus and glutæal nerves, and vessels; and below, to the superior gemellus, from which it is separated by the great, and lesser sciatic, and pudic nerves, and corresponding vessels. It is occasionally split by the sciatic nerve, which emerges between its fibres; or sometimes there may be a mutual interweaving of their structures.

Action.—To rotate the thigh outwards, and abduct and strengthen the posterior part of the capsular ligament. When this muscle does not accurately fill the superior part of the notch, it predisposes to sciatic hernia, which escapes between its upper edge and the glutæus minimus. Should a dislocation of the thigh-bone into the sciatic notch occur, the head of the femur lies on the pyriformis, below the glutæus medius, and covered by the glutæus maximus. The student should now recur to the description of the pudic, and sciatic arteries; and also to the external branches of the sacral plexus, as described in their proper sections.

Superior Gemellus.—A round muscular band, which arises from

the external surface of the spine of the ischium, and passing transversely outwards, is inserted into the digital fossa of the great trochanter, below the pyriformis, and above the tendon of the obturator internus, with which it is intimately connected.

Relations.—It lies on the bone and capsular ligament, and is covered by the glutæus maximus, greater and lesser sciatic nerves, with branches of the sciatic artery; having above it, the pyriformis, and below it the obturator internus tendon, from which it cannot be separated. This muscle is sometimes wanting, or may be represented by a cord of areolar tissue, and occasionally is inserted into the tendon of the pyriformis, without reaching the bone.

Obturator Internus, arises within the pelvis, from the deep or pelvic surface of the obturator foramen, except that part through which the vessels pass; from the ligament, which closes the opening; and from all that portion of the bone, which lies between the obturator foramen and the great sciatic notch, extending as high as the brim of the pelvis, as well as from the pelvic fascia. The internal fibres pass backwards, ascending a little, the middle and superior downwards and backwards; and the most posterior first curve a little forwards, then run backwards, all converging to the lesser sciatic notch, where they become attached to a tendon that is in their middle; then, partly tendinous and partly fleshy, it passes through that opening, between the spine and tuber ischii, a large bursa investing the surface of the bone, to facilitate the movements of the muscle on the cartilaginous trochlea it presents; on the fleshy fibres ceasing, the tendon is reflected at right angles outwards, and is inserted into the digital fossa, below the superior, and above the inferior gemellus.

Relations.—Within the pelvis, it lies on the bone, and obturator ligament, while the obturator fascia separates its deep surface from the levator ani, from the bladder, and from the obturator nerve, and vessels which course along its surface. In the notch, it is almost surrounded by a bursa, which is large and loose; the pudic artery, nerve, and vein lie above it, the nerve being nearest to the bone, its own nerve or the internal obturator also entering at this point in its course outwards; it is almost enveloped by the gemelli, having similar relations; and it is particularly adherent to the posterior surface of the capsule. Its tendon is likewise remarkable, for the fluted appearance it presents on its deep surface.

Inferior Gemellus.—Larger than the superior, and sometimes double, arises from a projecting rough prominence on the tuber ischii, below the lesser sciatic notch, and passing horizontally outwards, is inserted into the digital fossa, below the obturator internus.

Relations.—By its deep surface it corresponds to the bone, capsular ligament, and obturator bursa; superficially, to the glutæus maxi-

mus, and greater and lesser sciatic nerves; above, to the obturator internus; below, at its origin to the quadratus femoris; and, nearer to its insertion, to the obturator externus.

Action.—With the gemelli, it strengthens the capsule posteriorly, rotates outwards, and abducts.

Quadratus Femoris.—Situated below the last, and oblong in shape, arises from the outer edge of the tuber ischii, external and anterior to the semimembranosus, and passing horizontally outwards, is inserted into the posterior intertrochanteric line.

Relations.—Posteriorly, it is covered by the glutæus maximus, great sciatic nerve, and branches of the sciatic, and glutæal arteries; anteriorly, it lies on the bone, obturator externus, lesser trochanter, and insertion of the psoas and iliacus muscles; the upper margin, is parallel to the inferior gemellus; and the lower, to the adductor magnus, from which it is separated by the terminal branch of the internal circumflex artery. This muscle is sometimes absent altogether; and in a few cases, was found to take a much more extensive origin, so as to extend even to the ascending ramus of the ischium; in such cases, it is twisted above the margin of the adductor magnus.

Obturator Externus is seen by cutting across the quadratus; but even under those circumstances is only partially exposed, and should be examined again with the anterior region of the thigh. It arises fleshy from the inferior surface of the circumference of the obturator foramen, from the obturator ligament, and also from a strong fascia which completes the canal for the obturator vessels above; from this broad and expanded origin, the superior fibres pass obliquely downwards, forwards, and outwards, the middle horizontally, and the inferior slightly upwards; they all terminate on the surface of a strong tendon, which ascends backwards in a groove between the lower lip of the acetabulum and the tuber ischii, this groove being lined by a process of the capsular ligament and a synovial bursa; and winding now round the neck of the femur, it passes upwards, forwards, and outwards, to be inserted into the lowest part of the digital fossa of the great trochanter.

Relations.—Anteriorly it is covered by the pectineus, by a strong fibrous arch, and the obturator nerve, and artery. Its lower edge, is separated from the upper margin of the adductor brevis, by the internal circumflex artery; and the deep surface, rests on the bone, and obturator ligament; whilst in the groove, it lies inferior and internal to the capsular ligament, and is at first inferior and posterior, and then directly posterior to the neck of the bone.

Action.—To rotate outwards, to strengthen the capsular ligament inferiorly and internally, and likewise to assist in adduction; during states of extreme abduction the tendon of this muscle is put on the

stretch, affording a powerful obstacle to dislocation into the obturator foramen, which usually takes place when the limbs are widely apart. In a case of advanced rheumatic arthritis of the hip-joint we observed the tendon converted into bone, and the whole muscle degenerated into a ligamentous structure. In dislocations on the dorsum of the ilium, as well as into the sciatic notch, the tendon is torn from the fleshy fibres, but rarely from its insertion into the bone.

ANTERIOR REGION OF THE THIGH.

The thigh must now be supported on a block, with the anterior surface directed forwards, and the incisions previously made in the examination of femoral hernia prolonged downwards on either side, two inches below both condyles of the tibia; when on reflecting the flap, the superficial fascia is exposed, thick internally, but not so dense as on the external side; between its layers, the internal saphenous vein is seen on the inside, with the internal posterior cutaneous branch joining it, while several cutaneous nerves are also observed; thus the external cutaneous, a branch of the musculo-cutaneous, and the middle cutaneous, a branch of the anterior crural, pierce the sartorius, and fascia lata, three inches below Poupart's ligament; the internal cutaneous, which is sometimes double, and also derived from the anterior crural, perforates the fascia and sartorious, about two inches inferior to the last; and lastly, a branch of the internal saphenous pierces the sartorius, and fascia, and, curving forwards, one filament forms a plexus on the patella, while the other ramifies on the inner side of the knee-joint and the internal and anterior surface of the leg. The crural branch of the genito-crural, and short saphenous nerves, have been already described; but in addition to these, two or three small, slender, and flat branches of the anterior crural, pierce the fascia, and accompany the vein in the thigh. Thus on the anterior, external, and internal aspects of the thigh, there are seven cutaneous nerves, five being derived from the anterior crural, or its branches, and two from branches of the lumbar plexus. By now removing the superficial fascia, the fascia lata may be examined.

Fascia Lata.—Although descriptions of individual parts of the great fibrous investment of the thigh have been already given, still, in conformity with the convenience of examination, it will be requisite at present, to speak of the whole structure, extending from the limit of the thigh above, to the knee-joint inferiorly, as it exists in its integrity, as a sheath to preserve the position of the muscles, and to control their movements, but without subjecting them to any injurious pressure. Superiorly, it is attached to Poupart's ligament,

crest of the ilium, tubercles on the back of the sacrum, ascending ramus of the ischium, and descending ramus and symphysis of the pubis; inferiorly, and anteriorly, to the patella, and the involucrum of the knee-joint, which it assists in forming; and posteriorly, it passes over the popliteal space, adhering to those tendons which form its lateral boundaries, and becoming continuous with the fascia of the leg. Externally, it sends a process between the vastus externus in front, and the glutæus maximus and short head of the biceps behind, constituting the external intermuscular septum, which is attached to the outer side of the linea aspera, from the great trochanter to the external condyle; immediately above the latter process, it is thick and round, and can be traced downwards, covering and adhering to the external lateral ligament of the knee-joint; this septum is remarkably strong, but weaker above than below, and is pierced by the posterior branches of the external circumflex, and by the superior external articular artery. A similar process is sent in, on the internal side, between the vastus internus anteriorly, and the adductors posteriorly, and this is attached from the root of the lesser trochanter to the internal condyle; like the former, it is strong below, where it is thick, round, and incorporated with the tendon of the adductor magnus, and ultimately becomes continuous with the internal lateral ligament of the knee-joint; it is pierced above, by the internal circumflex; next in order by the first, and second perforating; then by the profunda femoris; then by the third, and fourth perforating; then by the femoral artery, and vein; and lastly, by the internal superior articular artery. A thinner sheet also sinks deeply, to separate the adductors from the posterior layer of muscles. Thus, in fact are constituted three great sheaths, one anterior, the second posterior, and the third internal, subdividing the muscles, into anterior, internal, and posterior sets. With very few exceptions, each muscle has likewise its special sheath, derived from the fascia; but these we prefer to describe with each distinct muscle, rather than enumerato them individually. The fascia lata itself, is composed of fibres passing in three different directions, the superficial transversely, the deeper longitudinally, and an intermediate or decussating set, lying between the two former; the difference in direction of the fibres observed in certain situations arising, not from any particular change in their course, but rather from the greater development of one set obscuring the others. The fascia may now be removed, in order to examine the muscles, which in this region are—tensor vaginæ femoris, sartorius, vastus externus, vastus internus, rectus femoris, cruræus, and sub-cruræus.

Tensor Vaginæ, occupying the upper and outer side of the thigh, and somewhat quadrilateral in shape, arises tendinous from the

outer side of the anterior superior spinous process of the ilium, and from the crest above that point, between the glutæus medius and the iliacus internus. It passes downwards and backwards, terminating in a broad expansion anteriorly, and a number of tendinous slips posteriorly, by which it is inserted into a sheath of the fascia lata, about the superior fourth of the thigh, below and behind the great trochanter.

Relations.—Externally, it is covered by the strong layer of fascia, which here appears tendinous; internally, it corresponds to the deep layer of fascia, beneath which lie the rectus, vastus externus, and ascending branches of the external circumflex artery; posteriorly, to the glutæus medius, a deep branch of the glutæal artery, passing downwards to anastomose with the circumflex, separating them; anteriorly, to the sartorius above; but somewhat lower, to a triangular space containing the rectus, branches of the anterior musculo-cutaneous nerve, with inferior ramusculi of the external circumflex artery; the terminal branch of the superior glutæal nerve, is in its sheath.

Action.—To make tense the fascia; and prevent displacement of the vastus externus, during its contraction; to flex the thigh and extend the leg, indirectly by acting on the fascia lata; also to rotate the thigh inwards, in which action it is associated with the glutæus medius, and the glutæus minimus, by the superior glutæal nerve.

Sartorius.—Long and flat, occupying the external, anterior, and inner sides of the thigh, and the superior part of the leg; arises from the anterior superior spine of the ilium, and from the upper part of a notch below that process, by a flat tendon, more marked posteriorly, than anteriorly; it becomes fleshy, almost immediately; and passing, at first downwards and inwards, then vertically downwards, on the internal side of the thigh, courses behind the internal condyle of the femur; there becoming tendinous, it curves forwards, over the internal condyle of the tibia, the tendon expanding below the inner side of the knee-joint; and is inserted into the internal and anterior side of the tibia, below the condyle, and above the gracilis, and semi-tendinosus.

Relations.—This is the most superficial muscle of the thigh, and the longest in the body; consequently, its deep relations are numerous. It lies immediately beneath the fascia, and crosses the psoas, iliacus, and rectus muscles, the femoral artery, vein, and internal saphenous nerve, the vastus internus, adductor longus, and magnus, the gracilis, with the internal lateral ligament of the knee joint, and the tibia in its upper third; the inner edge forms the outer boundary of Scarpa's angle, and therefore serves as a guide to the femoral artery in this region, but in the middle third it lies on the

strong fascia which constitutes the anterior wall of Hunter's canal, yet still always inclining towards its internal part; so that in the operation of securing the artery in this region it is a disputed point as to whether it should be drawn outwards or inwards, or divided; but from the figure of the surface, and the connexions of the muscle there is not a doubt,—and of this we have satisfied ourselves frequently,—but that it can be drawn inwards, with far greater facility than in the opposite direction; inferior to the canal, the muscle lies between the gracilis, and vastus internus, the saphena vein, and nerve lying at its posterior margin; and as the tendon curves forwards, it is concave upwards and forwards, and convex downwards and backwards; from the former, or concavity, a thin layer is continued over the synovial membrane of the knee-joint, as far as the patella; while from the latter, or convexity, a strong process passes downwards over the inner edge of the gastrocnemius, to become continuous with the fascia of the leg; its tendon is separated from the gracilis, above by the internal saphena vein, and nerve; and below, by a bursa; but still with the tendons of the gracilis, and semi-tendinosus, it forms that peculiar arrangement known as the goose's foot. In its course downwards, the muscle is pierced by three nerves, viz., the middle, and internal cutaneous, and the reflected cutaneous branch of the internal saphenous, that passes to the skin over the knee-joint; in its entire extent, it is enclosed in a separate sheath of the fascia lata, which is remarkable for its prismatic form; and in structure, it is likewise peculiar, in possessing but a small amount of tendinous tissue, and for its fibres running the whole length of the muscle, without any interruption.

Action.—To flex the leg, on the thigh; an the thigh, on the pelvis; to draw one leg, over the other; and if the leg is fixed, to rotate the pelvis to the opposite side.

Rectus Femoris, lies on the anterior and external part of the thigh, extending from the ilium to the patella. It arises by a thick round tendon, which grasps the anterior inferior spine of the ilium, this origin being anterior and internal; its second attachment, external and posterior to the other, is flat, thin, and curved, and springs from the upper and outer lip of the acetabulum, which sometimes presents a groove for its reception; both tendons pass downwards, forwards, and inwards, adhering to the capsular ligament of the hip-joint, and, having united, form at first a thick, round cord, that soon expands, but terminates on the upper third of the anterior surface of the muscle, while a narrow slip is sent downwards through its entire extent, as the middle tendon of insertion. The fleshy fibres arising from the posterior surface and sides of this slip, pass downwards and outwards, as applied to the mesial

line of the muscle ; and at the inferior third, become attached to the anterior surface of a tendinous expansion that contracts as it descends, and is inserted into the base of the patella, sending fibres also over the surface of that bone which become continuous with the ligamentum patellæ, through the medium of which the muscle is again inserted into the tubercle of the tibia. The direction of the entire muscle is downwards and inwards, in the axis of the femur ; but not so is its insertion through the patellar ligament, which is downwards and outwards, or in the axis of the tibia.

Relations and Structure.—This is a bipenniform muscle, owing to its fibres diverging from a mesial tendon ; and, while the tendon of origin is prolonged on the anterior surface, to facilitate the movements of the sartorius, that of insertion commences on the posterior surface, to allow a similar gliding on the subjacent cruræus. The external tendon of origin, which we have observed sometimes to be absent in advanced cases of rheumatic arthritis, lies on the bone and capsular ligament of the hip-joint, and is covered by the glutæus minimus, medius, and tensor vaginæ fermoris ; whilst the internal is found between the external tendon, and the iliacus, which overlaps it ; the remainder of the united tendon lies on the great trochanter, and vasti, covered by the sartorius ; the external branches of the external circumflex artery separate the deep surface from the cruræus above ; and descending branches of the same vessel, are found between them below ; in its inferior three-fourths, or below the sartorius, it is only covered by the fascia lata. The fibres of this muscle, are not above two inches in length, so that by contracting one-third of the length of each, they will only draw up the patella, to such an extent as to cause an extension of the leg ; but in consequence of the bipenniform arrangement, the fibres are multiplied so much in number, as greatly to augment its power. In some rare instances, the tendon may be ruptured above the patella ; but in the majority, that bone or its ligament yields before the tendon gives way. A transverse section of the rectus, exhibits the orifices of numerous branches of the external circumflex, proving the large vascular supply which the muscle receives.

Vastus Externus.—Flat and expanded, and lying on the outer side of the thigh ; also tendinous superiorly and externally, as well as inferiorly and internally, and larger above than below ; arises fleshy from the anterior part of the base of the great trochanter, which frequently exhibits a crest at this point for its attachment ; from the outer lip of the line leading from the great trochanter, to the linea aspera ; from the external side of that line ; from the femur ; from the external intermuscular septum, and fascia lata ; finally, from the outer condyloid line, external to the short head of the biceps. The superior

fibres pass obliquely downwards, forwards, and inwards; the inferior with less obliquity, forwards; and are attached, to a flat aponeurotic tendon, which is inserted into the outer edge of the tendon of the rectus, upper and outer margin of the patella, and by an expansion over the synovial membrane of the knee-joint, into the outer side of the head of the tibia.

Relations.—The anterior edge, corresponds to the cruræus, rectus, and patella with its ligament; the posterior, to the bone in front of the glutæus maximus, and short head of the biceps; the internal surface, to the femur and circular branches of the external circumflex, which also separate it from the cruræus; and to the synovial membrane of the joint; while it is covered externally by the fascia lata, tensor vaginæ femoris, and by the aponeurotic insertion of the glutæus maximus.

Vastus Internus.—Similar to the last in appearance, but smaller, and lying on the internal side of the thigh; arises from a ridge at the termination of the anterior intertrochanteric line, above the lesser trochanter; from the line leading from it to the linea aspera; from the inner lip of that line; and from the internal condyloid ridge. The fibres pass obliquely downwards, forwards, and outwards, forming a tendon on the deep surface, but not so well marked as that of the external vastus; which is inserted into the internal side of the rectus tendon; into the upper and inner part of the base of the patella; and by an expansion, into the inner side of the head of the tibia.

Relations.—Internally and anteriorly, with the psoas and iliacus, sartorius, adductors; the femoral, and profunda arteries, and veins; the anterior edge, fleshy, closely overlaps the cruræus, from which it can scarcely be separated; the posterior margin tendinous, is united to the adductors, and is covered by the internal hamstring muscles; while by its deep surface it corresponds to the bone, cruræus, and synovial membrane of the knee-joint.

Cruræus, found on the anterior and external surface of the femur, arises fleshy from the root of the anterior intertrochanteric line, and from the anterior and external side of the bone, for its superior three-fourths, as far back as the linea aspera; the fibres pass downwards and forwards, and are inserted in the posterior part of the rectus tendon, upper edge of the patella, and into the synovial membrane of the knee-joint.

Subcruræus.—A small, fleshy slip beneath the cruræus; arises from the anterior surface of the inferior fifth of the femur, also from the vastus internus; it passes downwards and forwards, and is attached to the synovial membrane of the joint, which it draws out from beneath the patella, during extension.

Relations of the Cruræus.—It is covered by the rectus, and vasti; and lies on the bone, and synovial membrane.

Action.—The muscles just described, viz., the rectus, cruræus, and two vasti, when taken conjointly, are named quadriceps extensor cruris; the rectus flexes the thigh on the pelvis, and extends the leg on the thigh; while the vasti, and cruræus, from having no attachment to the pelvis, extend the leg only. It will be observed, how the uniform expansion of these muscles, tends to increase the security of the knee-joint, and avert the many injuries to which the articulation is liable, as well on account of its exposed situation, as of the extensive surface it presents. Over the patella, a large bursa exists; and between the fascia, and quadriceps, a second is found, corresponding to the ligament that connects that bone to the tibia; these two synovial sacs always communicate; a third, is occasionally capable of demonstration, over the base of the tubercle of the tibia, and this also communicates with those above; nor is it extraordinary, that such communications should occur, when it is recollected that these sacs are only modified forms of areolar tissue. The rectus has a proper sheath, but the vasti, and the cruræus, are contained in a common investment.

INTERNAL REGION OF THE THIGH.

There are five muscles in this region,—gracilis, pectinæus, and the three adductors.

Gracilis.—Long and flat, like a band, and situated on the inner side of the thigh; arises by an oblong tendon from the symphysis pubis, between the spine, and the ascending ramus of the ischium: it soon becomes fleshy, with parallel fibres, and coursing downwards on the inner side of the thigh, terminates about the inferior fourth in a round tendon that passes behind the internal condyle of the femur, when it expands, and curving forwards is inserted into the internal and anterior part of the tibia, inferior and posterior to the sartorius.

Relations.—It lies on the adductors, longus, brevis, and magnus: on the internal lateral ligament of the knee-joint, from which it is separated by a bursa; and lastly, on the tibia; a prolongation being sent off from each margin, above to cover the synovial membrane, and below to the fascia of the leg; and it is covered by the fascia lata, the crus penis above, and by the sartorius below; while the internal saphenous vein crosses its anterior edge. The deep surface receives a branch from the obturator nerve.

Action.—To flex both the hip and knee-joint; to adduct and rotate the leg inwards.

Pectinæus.—Triangular in shape, with the base above and apex below, arises from the linea ileo-pectinæa, between the ilio-pubal

eminence externally, and the spine of the pubis internally; also from the surface below that line, and from the pubic fascia, which covers it. The fibres pass downwards, backwards, and outwards, converging, and are inserted by a tendon, into the line leading from the lesser trochanter to the linea aspera, below the iliacus internus, and above the adductor brevis.

Relations.—It is covered by the pubic portion of the fascia lata, and femoral vein at its pubic attachment; and near its insertion by the femoral, and profunda vessels; it lies on the bone, obturator externus with the nerve, and artery of the same name, and a variable portion of the adductor brevis; its inner edge corresponds to the adductor longus, but from which it is separated by an interval, filled up inferiorly by the adductor brevis, and sometimes by the first perforating artery; its outer edge answers to the psoas, iliacus, capsular ligament, and vastus internus. When the limb is rotated inwards, the tendon of this muscle has a twisted appearance, but this peculiarity disappears during the opposite motion. Its fibres are weak and fine, with but a small amount of areolar tissue in their intervals; the sheath is also thin and weak, and it is not unusual to observe it torn completely across in many subjects. This muscle is sometimes described, as the adductor minimus.

Action.—To flex, adduct, and rotate the thigh outwards.

ADDUCTOR LONGUS.—The most superficial of the three adductors, triangular in shape, with the base below and apex above, arises by a narrow tendon from the anterior surface of the symphysis pubis, between the spine, and angle; it forms a thick fleshy belly, increasing in width as it passes downwards, backwards, and outwards, and ends in a broad tendon, which sheaths the termination of the fleshy fibres, and is inserted into the middle third of the linea aspera, between the vastus internus in front, and the adductor magnus behind, being intimately united with both, to constitute the conjoined tendons.

Relations.—In the upper three-fourths it is merely subfascial, while inferiorly the sartorius crosses it, but is separated from it by the femoral vein, and artery. It lies on the adductor brevis, anterior division of the obturator nerve, and at its insertion, on the adductor magnus, but with the profunda artery, and vein intervening.

Action.—To adduct, flex, and rotate the thigh outwards.

ADDUCTOR BREVIS.—Deeper than the longus, and of a similar figure, but wider and thicker; arises by a strong round tendon from the symphysis pubis below and external to the adductor longus; it soon becomes fleshy, and passing downwards, backwards, and outwards, is inserted by a broad, but strong tendon, into the upper third of the linea aspera, above the adductor longus, and below the pectinæus.

Relations.—It is covered by the branches of the obturator nerve, adductor longus, and pectinæus, a small triangular portion appearing between the two last, on which the femoral, and profunda, arteries and their corresponding veins rest; and it lies on the adductor magnus and posterior branches of the obturator nerve; the superior edge is separated from the obturator externus, by the internal circumflex artery, while the tendon generally presents three openings for the three perforating branches of the profunda.

Action.—Similar to that of the long adductor.

Adductor Magnus.—In order to see this muscle completely, it must be dissected from the posterior, as well as from the anterior surface; it is triangular in shape, and arises by short, tendinous fasciculi from the lower part of the descending ramus of the pubis, ascending ramus of the ischium, and from the apex of the tuberosity of the ischium; the muscle becomes immediately fleshy and divided into fasciculi, which, passing downwards and outwards, are inserted, the more external, by a broad aponeurosis into the line leading from the great trochanter to the linea aspera, into the whole length of that line, and into the internal condyloid ridge; while the internal, more vertical, are collected into a thick, round band, that can be felt beneath the skin on the inner side of the thigh, and are then received into the upper and expanded part of a round tendon, that descends to be inserted into a well-marked elevation on the internal condyle of the femur, above the origin of the internal lateral ligament.

Relations.—Posteriorly, it is covered by the hamstring muscles, the great sciatic nerve, and by the glutæus maximus above; anteriorly, by the obturator externus, posterior division of the obturator nerve, adductor brevis, longus, pectinæus, femoral artery, vein, and saphenous nerve; internally, it corresponds to the fascia, sartorius, and gracilis; and externally, to the bone; while the superior edge is in relation to the quadratus femoris, obturator externus tendon, and termination of the internal circumflex of the profunda. The superior fibres, thick and strong, are often isolated from each other by large intervals; and the internal and external portions are also separated by the femoral artery, vein, and saphenous nerve. Near the femoral linear attachments six apertures exist, three of which are for the passage of the perforating arteries, one for the profunda, one for the obturator articular nerve, and one inferiorly, a very large tendinous opening for the femoral vessels.

Action.—To adduct, flex, and rotate the thigh outwards.

POSTERIOR REGION OF THIGH.

The Hamstring Muscles are three in number, namely, biceps flexor cruris, semi-tendinosus, and semi-membranosus, and are seen by turning the thigh on its anterior surface, and dissecting off the integuments, and fascia.

Biceps Flexor Cruris, consists of two heads, a long and short; the former arises by a strong tendon, from the superior and external part of the tuber ischii, where it is also connected to the tendon of the semi-tendinosus, and as it passes downwards, becomes thicker, and gives origin to the fleshy fibres of the muscle by its posterior surface; having now formed a fusiform belly, about two inches above the flexure of the knee-joint, it ends in a broad tendon, which receives the short head, that arises from the linea aspera, below the glutæus maximus tendon, and also from the external inter-muscular septum; it passes downwards, backwards, and outwards, and joining the first on its anterior surface, their conjoined tendon continues its course downwards, lying posterior and external to the external lateral ligament of the knee-joint, and dividing so as to inclose it in its bifurcation; of the two portions into which it splits, the anterior is inserted into the head of the fibula, and the posterior not only into the same bone, but also into external side of the head of the tibia, and also into fasciă of the leg.

Relations.—It is covered by the glutæus maximus in its upper third, and fascia lata in the rest of its course; while it lies on the semi-tendinosus, and semi-membranosus above, and on the vastus externus in its entire length; the sciatic nerve being first external, then crossing beneath it, and finally to its inner side; the peronæal nerve is parallel to its tendon, and the latter also covers the external lateral ligament, and external superior articular artery.

Action.—To flex the leg, and rotate it outwards when the knee-joint is flexed; also to extend the thigh on the pelvis, and support the body in the erect position.

Semi-tendinosus.—Long, flat, and slender; arises from the tuber ischii, and from the inner edge of the biceps tendon, for two or three inches; it forms a small fleshy belly, which, about four inches above the flexure of the joint, ends in a long, round, slender tendon, that passes downwards and inwards, behind the internal condyle of the femur, and is then reflected forwards, to be inserted into the internal side of the tibia, below and behind the gracilis, with which it is united.

Relations.—It lies on the adductor magnus, quadratus femoris, and below on the tendon of the semi-membranosus, which it separates from the inner head of the gastrocnemius, on the bone, inter-

nal lateral ligament of the knee-joint, and on the internal inferior articular artery; it is covered by the glutæus maximus, biceps, tendon of sartorius, fascia, and a bursa. This muscle is intersected about its middle by a tendinous line, exactly like the complexus cervicis.

Action.—To flex the leg, rotate the knee-joint inwards, and like the biceps flexor cruris, to support the body in the erect position.

Semi-membranosus.—Tendinous and aponeurotic, above and below, but fleshy in the middle; arises by a strong flat tendon, from the upper and outer part of the tuber ischii, deeper than the biceps, and semi-tendinosus; it becomes aponeurotic, and on the inner oblique margin, the fleshy fibres commence, forming at last a thick fleshy belly, which after a course of about five inches, is attached to the outer margin of an aponeurotic tendon, that, gradually contracting and assuming a rounded form, passes behind the inner condyle of the femur, and divides into three processes,—the first, a continuation of the original tendon, curves forwards, passing deeper than the sartorius, gracilis, and internal lateral ligament, and is inserted into a horizontal groove on the inner margin of the head of the tibia; the second, a thick, flat lamina (ligamentum posticum of Winslow), arising from the posterior and external edge of the tendon, passes upwards and outwards, beneath the semi-tendinosus, gastrocnemius, plantaris, popliteal artery, vein, and nerve, and is inserted into the internal side of the external condyle of the femur, sending a process over its posterior surface to the sheath of the poplitæus tendon; the third, a thin, but strong fascial layer, comes off from the lower curved edge of the tendon, and descending on the surface of the poplitæus muscle, is inserted into the popliteal line, there becoming continuous with the deep fascia of the leg.

Relations.—It is covered above by the glutæus maximus, semitendinosus, and biceps; and lies on the quadratus femoris, adductor magnus, the inner head of the gastrocnemius, and lastly on the tibia, with a bursa intervening between them; while the great sciatic nerve lies on its outer side, in its whole course. It has been already remarked, that the fascia is exceeding strong, where it invests the posterior surface of the tendons of the semitendinosus, and semi-membranosus, or the two inner hamstrings; but processes are also sent deep into the bone, to confine each in its distinct fibrous tubule, while on the external side the outer hamstring, or biceps tendon, is similarly retained by a fascial sheath; between the outer and inner hamstrings inferiorly, the upper half of the popliteal space is situated; but superiorly, they are merely separated by a cellular interval, through which a direct continuity of areolar tissue is established, from the pelvis to the popliteal region.

Action.—Similar to that of the semi-tendinosus.

DEEP ABDOMINAL MUSCLES.

Consist of five pair, if we consider the diaphragm to be composed of symmetrical halves, viz. : diaphragm, psoas magnus, and parvus, quadratus lumborum, and iliacus internus,

DIAPHRAGM.—In order to expose this muscular septum, the liver, kidneys, spleen, stomach, and duodenum should be removed, and the peritonæum cautiously detached from the fleshy portion, but great difficulty must be anticipated in the attempt to remove it from the central tendon. Another subject, in which the abdomen has not yet been opened, will give the most faithful view of the natural condition of the thoracic surface; and to see it properly, the lungs and pericardium, together with the pleural membrane, must be taken away. In the adult, the union of the fibrous pericardium to the cordiform tendon, is so intimate, that it is impossible to separate them unless with the knife, but in the fœtus such separation can be easily made. When fully exposed, the diaphragm will be seen to form an oblique septum, between the thoracic and abdominal cavities, being convex towards the former, and concave towards the latter; it is divided into a superior flat portion, termed the true or costal diaphragm, and an inferior or the crura, called the false or vertebral. The superior or costal division is elliptical in shape, longer in its transverse diameter, fleshy at the circumference, but tendinous in the centre; it arises by a broad, short, flat band from the posterior aspect and base of the ensiform cartilage; and by fleshy slips from the internal surface of the cartilages of the last true, and all the false ribs, likewise from their bony points; and finally from the ligamentum arcuatum externum, and internum; the anterior fibres pass backwards, the lateral upwards and inwards, the posterior almost vertically upwards, and are all inserted into the central or cordiform tendon, which occupies nearly the centre of the muscle. Of all those fibres the anterior are the shortest; the lateral, especially those of the right side, the longest; and the posterior, the most compact and best marked.

Cordiform Tendon, a dense, strong, fibrous structure, shaped like a trefoil leaf, and as such consisting of three leaflets—an anterior, right, and left; of these the anterior is the largest, and is very strong; the right somewhat smaller, but not so invariably; whilst the left is always the smallest, and weakest of the three. It presents a deep notch at its posterior edge, which receives the insertion of the crura, like the footstalk of a leaf. The tendon is narrow and thin, and the margins, which are irregular in their whole circumference, are identified with the lateral, anterior, and posterior fleshy fibres; the superior or thoracic surface is smooth, and the inferior

fasciculated, with the principal fibres radiating in a wavy manner from behind, forwards; while in addition, there are two other bands interwoven with, and crossing the former at acute angles; still on the inferior surface, particularly on the right side, a number of superadded fasciculi occur, which adhere but slightly to the tendon, and can be raised with facility from their position by the handle of a scalpel; from this mutual interlacement it is obvious great strength must result, with an unyielding power of resistance quite sufficient to oppose the retracting influence of the muscular fibres of opposite sides, four of these bands being specially engaged in circumscribing the opening for the vena cava.

Ligamentum Arcuatum Falsum, or Externum.—Merely the anterior layer of the transversalis abdominis tendon, folded on itself, is attached superiorly, to the lower edge of the last rib; and internally, to the root of the transverse process of the first lumbar vertebra. Its concave edge looks downwards and inwards; and beneath it, passes the last dorsal nerve, and quadratus lumborum muscle; its anterior surface is covered by the kidney, and fatty areolar tissue; and in order to make it tense and distinct, the rib should be everted and drawn backwards.

Ligamentum Arcuatum Internum, or Verum, arises from the attachment of the last to the root of the transverse process of the first lumbar vertebræ, and arching downwards, forwards, and inwards, is inserted into the root of the pedicle of the second lumbar, between the psoas magnus, and the posterior edge of the crus, the lower edge being prolonged for some distance on the psoas magnus, parvus, and sympathetic nerve, which emerge from beneath it.

Inferior, False, or Vertebral Diaphragm.—Consists of two fleshy pillars or crura, one on either side of the vertebral column, each being triangular in shape, with the base above and apex inferiorly; the right, which is also the most anterior, arises by tendinous bands from the forepart of the bodies of the four superior lumbar vertebræ, from the intervertebral substance, and the anterior vaginal ligament; while the left, which is shorter and more posterior, springs from the sides of the bodies of the three superior lumbar vertebræ, and vertebral ligaments; the tendons of both pass upwards, and are united superiorly to form an arch, for the purpose of bounding anteriorly the aortic opening; and to their anterior, superior, and external edge, the fleshy crura are attached, the fibres of which radiate, and run upwards and forwards, to be inserted into the notched or posterior edge of the cordiform tendon; from the summit of the aortic arch, and from the deep surface of the tendon, two fleshy muscular bands arise, the right being the more anterior, and crossing the left; these are the decussating fibres of the crura, which are continued upwards and

forwards, to be inserted into the inferior surface of the central tendon, near the posterior edge; the angle of decussation being immediately behind the œsophageal, and in front of the aortic opening, and therefore separating those orifices. But although the right fasciculus is anterior at the point of decussation, the position becomes altered at the point of insertion, the left being at the right and anterior segment of the œsophageal opening, while the right is at the left and posterior edge.

The Openings in the Diaphragm are divided into those which are single, viz., the aortic, œsophageal and caval; and those which are double, viz., two triangular spaces, behind the ensiform cartilage, with two others, on each side, for the greater and lesser splanchnic nerves —all of which should now be separately examined.

Aortic Opening, or *Canal*, as, more critically speaking, it should be called, corresponds to the eleventh and twelfth dorsal, and upper margin of the first lumbar, vertebræ; and is about one inch and a half in length; infundibuliform in shape, it is large, wide, and fleshy on the thoracic aspect, but constricted and tendinous on the abdominal, the latter not being well defined, owing to the fibrous arch sending a prolongation downwards, on the aorta, and cœliac axis; the canal is bounded anteriorly, by the aortic arch, and decussating fasciculi; posteriorly, by the bodies of the vertebræ, anterior common ligament of the spine, and by the origins of the left crus; and laterally, by the two crura. The aorta passes through its centre, with the venā azygos, and thoracic duct on the right side; and the vena azygos minor on the left; while occasionally the splanchnic nerves may also accompany those vessels. The tendinous arrangement of the outlet of the canal, averts all injurious compression of the vessel inferiorly; and superiorly, its size obviates a similar consequence.

Caval Opening.—To rightly examine this opening, the liver should be removed when it will be seen to be quadrilateral in shape on the abdominal aspect, and bounded by the four tendinous fasciculi already described, while on the thoracic surface the figure is somewhat oval; as the v. cava passes through this fibrous ring, the anterior edge is prolonged, on the abdominal surface, as far as the liver, where it becomes continuous with the capsule of Glisson; while the posterior margin is prolonged upwards, on the thoracic portion as far as the right auricle; the lateral also ascending for some distance on the vein, and then terminating abruptly. This opening is on a level with the tenth dorsal vertebra, formed in the structure where the middle and the right leaves of the central tendon unite, and through it pass the vena cava inferior, and a few filaments of the phrenic nerve. In many diving animals, this aperture is perfectly muscular, such being the structure in the otter; but although it presents all

the characters of a sphincter, there is this peculiarity,—that an aponeurotic expansion is prolonged from the muscular opening, which invests the intrapericardial portion of the inferior cava; and in such instances the latter vessel, together with the hepatic veins, exhibit a normal dilatation within the abdomen. This dilatation does not however appear to be dependent on the muscularity of the orifice; it equally exists in the tribe of aquatic birds, as in the northern diver, although the diaphragm is in them, merely rudimentary.

Œsophageal Opening, situated on a level with the ninth dorsal vertebra, is elliptical in shape, and placed behind the left leaf of the central tendon, anterior and to the left side of the aortic opening. Its structure is muscular, and formed by the decussating fasciculi of the crura; but sometimes, the anterior edge is tendinous; while occasionally, a thin slip passes on the surface of the œsophagus, downwards to the stomach. Through it pass the œsophagus, pneumogastric nerves, and the ascending branch of the coronaria ventriculi artery. Occasionally, we have seen this opening fully half an inch larger than the tube; a condition calculated to promote the occurrence of diaphragmatic hernia, when of course a portion of the stomach would form the contents of the sac. We have also observed in a case of constant vomiting, caused by a carcinomatous affection of the stomach, the œsophagus presenting a circular indentation, from the margins of the opening impressing it, the coats of the tube being thickened, but without any dilatation.

Costo-xiphoid Space.—The diaphragm is attached to the posterior surface of the ensiform cartilage at its base, by a flat band, which is sometimes single, and sometimes separated by an indistinct cellular line, into two. Between this band, and the first costal origin, with the base in front, formed by the costo-xiphoid ligament, there exists a triangular opening on each side known as the costo-xiphoid space but when the central slip is absent, which is sometimes the case, only one aperture occurs. Through either passes the abdominal branch of the internal mammary artery, a mass of areolar tissue freely communicating between the two cavities, and, in the case of central deficiency, an absolute contact of the serous membranes of the thorax and abdomen exists. Through that on the right, the anterior superficial absorbents of the liver also ascend, in their course to reach the glands in the anterior mediastinum.

Neural Openings, are four in number, two on each side; properly speaking, they are nothing more than mere slits in the fibres of the crura, the greater splanchnic nerve passing through them most anteriorly, and dividing the crus into an anterior, and, posterior portion: while the lesser pierce the sheet of the diaphragm itself, more posteriorly behind the crura.

Costal Fasciculi.—We have occasionally seen each costal origin forming a distinct slip, and indigitating with the corresponding origins of the transversalis abdominis, or, more correctly speaking, apposed to those of that muscle; a mutual interposition of fasciculi being rarely, if ever, observed. Those slips presented in some cases merely slight cellular intervals, but in others the separation was so manifest, that the pleura and peritonæum were united, for at least half an inch in width, near those costal attachments of the diaphragm. The origins from the eleventh and twelfth ribs are tendinous, and are not in apposition with the transversalis; nearly three-quarters of an inch intervening between them, the intercostal nerves, and arteries escaping through the intervals between them.

Relations.—The superior surface of the diaphragm is arched, but more so on the right than on the left side; while anteriorly, it is almost horizontal; the highest point of the right half, is on a level with the cartilage of the fourth rib; and that of the left with the fifth. It is covered by the pleuræ, bases of the lungs, pericardium, and heart; while inferiorly, it corresponds to the liver, stomach, kidneys, suprarenal capsules, spleen, and peritonæum. On the right crus, rest the liver, pancreas, suprarenal capsules, kidney, semilunar ganglion, right phrenic artery, vena cava, and porta, the hepatic artery, superior transverse portion of the duodenum, and the renal artery; and on the left crus, lie the spleen, left lateral ligament of the liver, kidney, suprarenal capsule, tail of the pancreas, œsophagus, pneumo-gastric, and left phrenic nerves, renal, splenic, superior and inferior mesenteric arteries, semilunar ganglion, and the aorta.

Action.—Haller believed the diaphragm to rank only second in importance to the heart, as being the principal and indispensable agent in the function of respiration. Although placed within the cavity of the body, and internal to the levers on which it is destined to act, like the motive structures of invertebrate animals, it is by no means an organ universally present in the animal series; being in its perfect state peculiar to mammalia; a substitute existing in birds, consists of two fleshy fasciculi, arising from the ensiform cartilage, and attached to the base of the lungs, the intervals on either side, being occupied by the upper extremities of the air sacs In mammalia, it pertains to the class of mixed muscles, possessing some characters of both classes; thus it is red, attached to bone, equally composed of tendon and muscular structure, supplied by the cerebro-spinal system, is partially under the control of volition, and contains striped fibres,- these being the distinctive characters of voluntary muscles. Again, it is contained within a cavity, is thin and expanded, placed between two serous membranes, the fibres, like those of the heart, are feebly striped, and its contractions are

rhythmical, continuing during sleep and cerebral lesions that annihilate volition, and it is supplied by the sympathetic system—these constituting the more important features of the organic system of muscles. As the great inspiratory muscle, it acts both in ordinary and extraordinary inspirations; in the former, the ribs being fixed by the intercostals, the diaphragm descends, by its contraction becoming a plane instead of a concavo-convex surface, the crura from below, and the pericardium from above, fixing the cordiform tendon in this movement. In extraordinary inspiration, the action is the same, but in this case it is assisted by all the subsidiary muscles. The diaphragm is antagonized directly, by the abdominal muscles, and the levatores ani; as these, by pressing the abdominal viscera upwards, against its lower surface, cause its relaxation. In its contraction, it assists in expelling the contents of the hollow viscera; produces sneezing, the mechanism being a slow inspiration, followed by a sudden expiration; and it also assists in coughing. The diaphragm is supplied by the phrenic nerves, branches of the cervical plexus, and the sympathetic. The vessels distributed to it, are the inferior diaphragmatic, or phrenic branches of the abdominal aorta; the six inferior intercostal, or lateral diaphragmatic; the comes nervi phrenici, or middle diaphragmatic, and the musculo-phrenic, or superior diaphragmatic arteries.

Psoas Parvus.—Sometimes wanting, but when present is thick, round, and fleshy above, and tendinous and expanded inferiorly. It arises, by two semicircular tendinous bands, from the sides of the bodies of the last dorsal and first lumbar vertebræ; to these succeed a short fleshy belly, that ends in a tendon, which is inserted broad into the linea ileo-pectinea, and junction of the pubic and iliac fasciæ, on the point behind the terminal portion of the external iliac artery; occasionally, the outer edge of the tendon is continued, as a falciform edge or process, upwards and outwards, over the iliacus internus, to the anterior superior spine of the ilium.

Relations.—It lies anterior and internal to the psoas magnus, and the anterior surface has similar relations to that muscle.

Action.—To bend the body forwards; also to make tense the fascia, and sheath of the femoral vessels.

Psoas Magnus.—Narrow above and below, but wide in the middle, placed on the sides of the spine, on the brim of the pelvis, and on the anterior and inner part of the thigh. It arises, by short tendinous fibres, from the anterior surface of the transverse processes of all the lumbar vertebræ; and from the sides of the bodies of the two last dorsal, and four first lumbar, by tendinous arches, five in number, the extremities of each being attached to the projecting margin of the vertebræ, and intervertebral substance; beneath these arches, pass

the lumbar arteries, and veins, with branches of the sympathetic nerve; the fibres, forming a thick mass, pass downwards and outwards over the brim, but drooping a little into the cavity of the true pelvis, then descend under Poupart's ligament, forming a tendon on its outer side, but continuing fleshy internally; in the thigh this turns at first downwards, backwards, and inwards, but afterwards is reflected a little outwards, and is inserted into the posterior and inferior part of the lesser trochanter, and the ridge below that point.

Relations.—Superiorly, or in the abdominal portion, it is covered by the crus of the diaphragm, and ligamentum arcuatum internum, psoas parvus, kidney, and renal vessels, the ureter, spermatic vessels, iliac fascia, external iliac artery, and genito-crural nerve; posteriorly, it rests on the transverse processes of the vertebræ, quadratus lumborum, from which it is separated by the external branches of the lumbar arteries, and the anterior lamina of the transversalis abdominis tendon, as also by a few branches of the lumbar plexus; lower down, it rests on the brim of the pelvis, and iliac sulcus. The internal edge corresponds to the crus of the diaphragm, and sympathetic trunk; the external to the quadratus lumborum; and lower down, to the iliacus internus, and anterior crural nerve. In the femoral portion it is covered by the sartorius, femoral artery, and vein; profunda artery, and vein; external circumflex, and the anterior layer of the pubic fascia. It lies on the capsular ligament of the hip-joint, with a bursa and the posterior layer of the pubic fascia intervening; sometimes this bursa communicates with the joint, a deficiency existing in the capsule, in which case the tendon of the muscle lies in contact with the neck of the femur; and at its insertion, it also has posterior to it, the transverse fibres of the adductor magnus. The iliac sulcus, exists between the ilio-pubal eminence and the anterior inferior spine of the ilium; and the psoas escapes on its internal third, between the insertion of the psoas parvus, and the iliacus; and then between the iliacus and the pectinæus, still having the iliacus to its outer side. Two-thirds from its anterior surface, the lumbar plexus is formed, and its branches as they lie in the substance of the muscle apparently divide it into two distinct portions—one arising from the bodies; the other springing from the transverse process. The psoas muscle is often the seat of abscess,—in the majority of cases consequent on caries of the vertebræ. The matter in such instances follows the course of the muscle, and becomes evident in the groin, two circumstances promoting the descent of the purulent depôt,—firstly, the lax areolar tissue, which connects its fibres to each other; and secondly, the fibrous layers which inclose it, constituting the psoas sheath. Above the iliac fossa, the anterior surface of the muscle is covered by the continuation of the ligamentum arcuatum verum,

and a process derived from the tendons of the crura, which also binds down the sympathetic nerve; whilst posteriorly, the strong anterior lamina of the transversalis abdominis tendon, presents an obstacle, to the escape of the contents in that direction, rarely overcome. At the outer edge of the psoas, the iliac fascia sends a process posteriorly, where it is also supported by the bone; but the principal portion of the fascia passes on the anterior surface, both becoming again continuous at the inner edge of the muscle. In the thigh, the pubic portion of fascia lata divides into two laminæ of unequal thickness, the posterior being weak, as the muscle is supported in this situation by the fibrous capsule of the joint; but the anterior much stronger, where it receives additional strength from the posterior layer of the femoral sheath. On examining this sheath, in the normal state, many points appear, where its manifest weakness ought to permit these accumulations to escape readily; but when it is recollected that the inflammation, preceding their formation, is slow and chronic, will offer a sufficient explanation of the enormous thickening of this structure observed in those cases, where every trace of muscular tissue may have been removed, either by the pressure of the matter, or breaking down of the fibres, or from long disuse of the muscle, or all these causes combined.

Action.—To draw forwards and flex the thigh, and to rotate it outwards; to keep the spine erect, and bend it to one side.

Quadratus Lumborum.—External and posterior to the great psoas, is oblong in shape, and stretched between the last rib and the crest of the ilium. It arises from the posterior fourth of the crest of the ilium, and from the ilio-lumbar ligament, by short tendinous fibres, which pass upwards and inwards; the external, being inserted into the lower edge of the last rib for about two inches and a half; and the internal, by four tendinous and fleshy slips, into the summit of the transverse processes of the four first lumbar vertebræ; where these terminate, three fleshy slips frequently pass upwards and outwards, superficial to the remainder of the muscle, crossing its fibres at acute angles, and are inserted into the last rib.

Relations.—It is between the anterior, and middle layers, of the transversalis abdominis tendon, the last dorsal nerve, lumbar arteries, psoas, kidney, crus of the diaphragm, being also anterior to it. Its resemblance to the rectus abdominis, in being inclosed in a fibrous sheath, is sometimes still further increased, by the presence in its structure, of a transverse tendinous intersection.

Action.—To depress the last rib, also to bend the spine to its own side; and if the spine be fixed, to elevate the pelvis.

Iliacus Internus.—Seen by removing the iliac fascia; broad and triangular above, but narrow inferiorly; it arises, from all the

iliac fossa, from the three anterior fourths of the crest of the ilium, from the anterior superior and inferior spines, and the notch between them, from the iliac fascia and brim of the acetabulum, and from the last lumbar transverse process; the fibres converge, passing over the iliac sulcus on the brim of the acetabulum, and are inserted into the outer side of the tendon of the psoas. The united tendon now runs down to the lesser trochanter, which is embraced by its posterior surface; and is ultimately inserted into the line below it, and into the posterior and inferior part of that process.

Relations.—It is covered by the iliac fascia, cellular tissue and cœcum on the right side; and by the sigmoid flexure of the colon, and the musculo-cutaneous nerve, on the left; it is separated internally from the psoas, by the anterior crural; and it lies on the bone, ilio-lumbar artery, and ligament. The femoral portion is covered by the sartorius, femoral, profunda, and external circumflex arteries; and lies on the capsular ligament, and adductor magnus. The lax areolar tissue lying between the cœcum, and iliac fascia, sometimes suppurates, constituting *ilio-cœcal abscess*; or, again, an abscess may form within the muscle, and this is considered an *iliac abscess.*

Action.—To flex the thigh, and rotate it outwards, and also advance it forwards, as in progression.

ANATOMY OF THE LEG.

The integument of the leg is strong and dense, anteriorly and externally; but much finer and more sensitive, on the inner surface, and crest of the tibia. In all the situations enumerated, it is fixed to the subjacent structures almost immoveably; but posteriorly, it is thick, fine, and soft, and very moveable, as well as on the dorsum of the foot and toes, where it is so thin, that the cutaneous veins are visible, even to the smallest branches, forming a remarkable contrast with the similar structure of the sole, or plantar region, being here dense and horny, except internally, where it is fine, polished, and transparent. The surface, is generally covered with hairs, in the adult, which are more numerous on the anterior region, than on the posterior; they are few in number, but fine and prolonged, on the dorsum of the foot; and again, they are totally absent, in the plantar region. An incision should now be carried, from the knee to the great toe, along the crest of the tibia, the skin reflected outwards, and the superficial fascia exposed; the latter merely a continuation of the same tissue from the thigh, sometimes containing fat, but usually laminated, is much weaker on the dorsum of the foot than on the leg; and between its layers the following parts are seen:—The internal saphenous vein, and nerve, with the musculo-cutaneous

nerve. The internal saphenous vein, commences from an arch on the dorsum of the foot, situated over the proximal extremities of the metatarsal bones; receiving in front, cutaneous branches from the toes; and by the internal and external extremity, giving origin to the saphenous trunks; the vein then ascends, in front of the internal malleolus, and on the inner side of the leg, over the internal edge of the gastrocnemius; then passes between the tendons of the gracilis, and sartorius muscles, and commences its femoral stage, lying in its whole extent in the structure of the superficial fascia until it opens ultimately, as already stated, into the femoral. The internal saphenous nerve, a branch of the anterior crural, accompanies the femoral artery in the thigh, runs along the tendon of the adductor magnus, and, passing beneath the saphena vein, between the tendons before mentioned, reaches the leg; then winding to the anterior part of the vein, follows its course, and terminates on the inner side of the dorsum of the foot. Musculo-cutaneous nerve, a branch of the peronæal, descends between the peronæus longus, and extensor digitorum communis; as far as the lower third of the leg, where it becomes superficial, and divides into internal, and external, tarsal branches, that are distributed—the external, to the three outer toes; and the internal, to the two inner (see ANATOMY OF NERVES).

When the superficial fascia is removed, the proper investment of the anterior surface of the leg is exposed, and with this may be described the whole fascial envelope, as it surrounds the limb, forming three sheaths,—an anterior, external, and posterior, and producing a corresponding arrangement of the muscles; the superior circumference is attached anteriorly, to the head of the tibia, fibula, and tendon of biceps; posteriorly, it is continuous with the fascia lata, and strengthened by expansions from the gracilis, sartorius, semitendinosus, and biceps; while inferiorly, it is attached to the annular ligaments; anteriorly, the fascia is strong with the fibres interlacing at acute angles, and is attached to the spine of the tibia, for its whole length; but posteriorly, it is much weaker, the direction of the fibres being circular. By now removing the fascia from the anterior region, taking care to commence from below, where it can be raised with facility, as above it is so intimately connected to the parts beneath, that a few of their fibres are always detached with it, the following muscles, four in number, will be exposed:—tibialis anticus, extensor pollicis proprius, extensor digitorum communis, and peronæus tertius. But before examining those muscles, the student should refer to the anatomy of the LIGAMENTS, for a description of the anterior annular ligament.

TIBIALIS ANTICUS.—Triangular, or prismatic in shape, fleshy above but tendinous below, arises from the outer side of the head of the

tibia, also from the concave surface of the bone for the upper two-thirds, from the fascia, and intermuscular septum, which separates it from the extensor communis, and from the inner half of the interosseous membrane. It passes obliquely downwards, forwards, and inwards, the fleshy fibres, at the inferior third, surrounding a tendon which runs beneath the annular ligament, then over the astragalus, and navicular bones, and becoming flattened, is inserted into the inner side of the internal cuneiform bone; and by a flat slip, into the base of the metatarsal bone of the great toe.

Relations.—It is covered by the fascia; and rests on the interosseous membrane, tibia, astragalus, and navicular bones; at its insertion, lies between the abductor pollicis and the bone, and a bursa separates it from the upper and inner part of the internal cuneiform; the external edge corresponds to the extensor digitorum, extensor pollicis proprius, and the anterior tibial artery, and nerve.

Action.—To flex the ankle-joint, and raise the inner side of the foot from the ground; to press the astragalus firmly against the internal malleolus, and to limit eversion. In the congenital deformity named, *pes varus*, this tendon is shortened, and frequently requires division.

Extensor Pollicis Proprius.—A semipenniform muscle; arises fleshy and narrow, from the anterior grooved surface of the middle third of the fibula, and from the interosseous ligament; the fibres pass downwards and forwards, to reach a tendon, formed on the anterior surface of the muscle, which then runs downwards, forwards, and inwards, under the annular ligament, in a separate groove; then over the astragalus, navicular, internal cuneiform, metatarsal, and phalangeal bones; and expanding, is inserted into the last, or ungual, phalanx, of the great toe.

Relations.—Internally, tibialis anticus, tibial artery, and nerve; externally, extensor communis, and at the annular ligament the tibial artery, and nerve, which cross beneath the tendon to its outer side. It is usually concealed by the overlapping of the muscles on each side of it; and the groove in the annular ligament, through which it runs, is only complete anteriorly, and not posteriorly.

Action.—To extend the great toe, and flex the ankle-joint.

Extensor Digitorum Communis.—Also a semipenniform muscle, arises fleshy from the outer side of the head of the tibia, from the two superior thirds of the inner edge of the fibula, and also from the interosseous ligament; the superior fibres pass vertically, the middle and inferior downwards and forwards, to be attached to a tendon which commences on the anterior surface of the inferior third of the muscle; above the ankle-joint, this tendon divides into two portions, an internal, and an external, which remaining in contact, pass through a

groove in the annular ligament, then wind forwards and outwards on the dorsum of the foot, each dividing into two slips, which diverge, and continue their course over the tarsus and metatarsus; and then along the phalanges on the outer edge of the short extensor; at the first phalanx they receive the insertions of the lumbricales, and interossei; and at the first interphalangeal articulation, each divides into three slips, one of which is inserted into the base of the second phalanx, while the lateral, passing forwards and again uniting, are inserted into the posterior margin of the last phalanx.

Relations.—It is covered by the fascia of the leg, and lies on the interosseous ligament and fibula; the external edge corresponds to the peronæus longus, and musculo-cutaneous nerve; and inferiorly, to the external malleolus, which separates it from the peronæus brevis; internally, and superiorly, it is in contact with the tibialis anticus and anterior tibial artery, and nerve; and below, with the extensor pollicis proprius; on the dorsum of the foot, it lies on the short extensor, and is contained in a proper fibrous sheath; while in the superior part of the leg, a thin septum separates it from the tibialis anticus, and a much stronger lamina from the peronæus longus, the sheath being completed posteriorly by the interosseous membrane. The superior part of the muscle, is pierced by the anterior tibial nerve.

Action.—To extend the toes, and flex the ankle-joint.

Peronæus Tertius, or Anticus, arises from the anterior surface of the inferior third of the fibula, where it is inseparably blended with the long extensor; it forms a tendon which passes through the annular ligament, in the same groove with that extensor, then runs outwards and forwards, on the dorsum of the foot, and is inserted into the metatarsal bone of the fifth toe.

Relations.—The same as those of the extensor pollicis proprius.

Action.—To turn the foot outwards, and flex the ankle-joint.

The muscles on the external side of the side of the leg are two in number,—peronæus longus, and peronæus brevis.

Peronæus Longus, lies on the outer side of the leg, and is fleshy above, but tendinous below; it arises fleshy from the outer side of the tibia, from the head and upper third of the outer angle of the fibula, by tendinous laminæ which separate the anterior and posterior muscles of the leg; it then descends, and in the lower half of its course, the fleshy fibres surround the tendon, which runs downwards, outwards, and backwards, so as to reach the posterior surface of the external malleolus, where it is received into a shallow groove with the peronæus brevis, but separated from the bone by a bursa and a layer of stratiform cartilage, and preserved in position by a fibrous sheath; it now winds downwards and forwards, crossing the middle slip of the external lateral ligament, and grooves the side of

the os calcis, and under surface of the cuboid bone; it now turns forwards and inwards, and is inserted directly into the base of the metatarsal bone of the great and that of the second toe; and by a tendinous slip into the external sesamoid, at the base of the first phalanx; also occasionally, into the internal cuneiform.

Relations.—It lies on the fibula, and peronæus brevis; and is separated anteriorly, from the common extensor, by the musculo-cutaneous nerve, and an intermuscular septum; and posteriorly, from the soleus above, and the flexor pollicis below, by a similar fibrous layer. The tendon grooves three bones,—fibula, os calcis, and cuboid; and has three bursal sacs, corresponding to those grooves, with separate fibrous sheaths, the last being an expansion of the calcaneo-scaphoid ligament. In the sole of the foot, the tendon is close to the tarsal bones, and above all the soft parts in this region.

Action.—This is a powerful muscle, in consequence of the peculiar reflection of its tendon, at right angles nearly, to the lever on which it acts. By its action, the ankle-joint is extended, and the toes everted; whilst the weight of the body, is thrown on the internal arch of the foot, which, by the elasticity of the calceo-scaphoid ligament, averts the injurious effects of shocks in leaping, &c. In partial and complete dislocation of the tibia inwards, this muscle produces in a great degree the displacement consequent on that accident, and it is also a source of the congenital deformity termed, *pes valgus.* A dislocation of this tendon, where it slips to the forepart of the external malleolus, has been observed by the late Mr. Wilson.

Peronæus Brevis.—Shorter than the last, beneath which it lies; arises from the outer and back part of the inferior half of the fibula, and continues fleshy, to within an inch of the external malleolus; though the tendon is formed in the muscle near its commencement, the fibres being at first attached to it so as to produce a bipenniform muscle, but afterwards it is semipenniform; coursing at first downwards, but soon turning backwards, it grooves the external malleolus, and then winding forwards on the os calcis, which it also grooves, in common with the peronæus longus, but above that muscle, it expands, and is inserted into the projecting extremity and base of the metatarsal bone of the fifth toe.

Relations.—It is covered by the peronæus longus, and lies on the fibula, and external malleolus. It grooves two bones,—external malleolus, and os calcis.

Action.—Similar to that of the peronæus longus.

On removing the integument on the posterior surface of the leg with the superficial fascia, the posterior saphenous vein, and nerve are seen,—the vein commencing at the outer extremity of the tarsal arch of veins, and ascending behind the external malleolus,

pierces the fascia, and opens into the poplitæal vein, opposite the flexure of the knee-joint; or sometimes, it winds round the inner side of the thigh, and joins the internal saphena. The posterior saphenous nerve, is formed by a branch from the posterior tibial (communicans tibialis) and a smaller one from the peroneal (communicans peronæi); these converge as they descend, and at last unite in the upper third of the leg, to form the posterior saphenus nerve, which lies at first deeper than the vein, in a fibrous canal beneath the fascia, then, becoming superficial to that vessel, passes behind the external malleolus, gives off calcaneal branches, and terminates in the integument of the fifth toe, where it communicates with the external dorsal, and plantar nerves. When these have been removed, the posterior muscles may be examined; they consist of two layers,—a superficial and deep, the former being three in number,—gastrocnemius, soleus, and plantaris; and the latter four,—poplitæus, flexor digitorum communis, flexor pollicis proprius, and tibialis posticus.

Gastrocnemius.—Bicipital above, and tendinous inferiorly; arises by two triangular or oval heads, which are tendinous on their deep surface, the external being the shorter of the two, and from two prominent ridges, above and behind the condyles of the femur; having descended to about the superior fifth of the leg, they unite and form a wide fleshy belly, which at the middle of the leg again divides into two terminal bellies, which are attached to a tendon, flat and wide above, but thick and round inferiorly; this descends in the original direction of the muscle, and, after expanding a little, is inserted into the posterior and inferior part of the os calcis, constituting, with the tendon of the soleus, what has been called the *tendo Achillis.*

Relations.—The external head lies on the femur, the tendon of the poplitæus, and the prolongation of the synovial membrane connected with that tendon; on the ligamentum posticum of Winslow, external inferior articular artery, some fibres of the plantaris, and the tibio-fibular articulation, with the outer head of the soleus; its outer edge corresponds to the biceps tendon, from which it is separated by the peronæal nerve; and its inner, to the poplitæal space, and its contents; while the posterior surface, is subfascial. The internal head, much longer, lies on the femur, on a large bursa which sometimes communicates with the joint, on the ligament of Winslow, internal inferior artery, and poplitæus; the outer edge corresponds to the poplitæal space, and its contents; and the inner, to the semitendinosus and semimembranosus tendons; while the posterior surface, is subfascial. The fleshy belly, convex behind, is covered by the skin, two layers of fascia, and the posterior saphenous vein, and nerve; and lies on the soleus, and plantaris; the outer edge corre-

sponding to the peronæus brevis; and the inner, to the internal saphenous vein, and nerve. The tendo Achillis stands out prominently, behind and lies on the deep fascia; it is bordered externally, by the posterior saphenous vein, and nerve; while the inner edge serves as a guide to cutting down on the posterior tibial artery, in the inferior third of the leg. It is separated, from the os calcis above, by a bursa; and covered posteriorly, by fat, beneath which also a bursa often exists.

Action.—This is the most powerful muscle in the body, in consequence of its being inserted at right angles to the lever on which it acts; it serves the purpose of an active ligament, by extending the ankle-joint, as in progression, when it represents in action, a lever of the second order, the fulcrum being at the toes, the power at the insertion of the tendon, and the weight transmitted through the tibia to the astragalus. But if the foot is raised from the ground during extension of the ankle, it represents a lever of the first order, the power being behind, the weight anteriorly, and the fulcrum intermediate. Here it may be mentioned, that flexion of the ankle represents the third order of lever, the weight being in front at the toes, the fulcrum posteriorly at the joint, and the power intermediate between them at the insertion of the tibialis anticus, &c. In progression, the second order of lever occurs, because, being the most powerful, it contributes a greater facility to that motion; but the sudden contraction of the muscular fibres sometimes ruptures the tendo Achillis,—an accident most liable to take place in fat, heavy, or aged persons. The gastrocnemius also assists in flexing the knee-joint, and is of much service in strengthening that articulation, by preventing displacement of the tibia backwards.

Plantaris, lies beneath the gastrocnemius, on dividing which, it will be seen to arise fleshy from the ligament of Winslow, where it joins the capsule of the joint, and from the termination of the outer lip of the linea aspera; it forms a fleshy belly, about three inches in length, which terminates in a membranous narrow tendon, but yet the longest in the body; it descends at first between the gastrocnemius, and soleus; then running along the inner edge of the tendo Achillis, is inserted into the os calcis, anterior and internal to that tendon; or, it may sometimes terminate by expanding in the fascia, on the inner side of the common tendon.

Relations.—Those of its fleshy belly are precisely similar to those of the outer head of the gastrocnemius; its tendon lies, above on the soleus and below on the deep fascia; and is covered by the gastrocnemius, and the superficial fascia.

Use.—To make tense the fascia.

Soleus.—Arises by two heads; the external, tendinous, from the superior third, and inner edge, of the posterior surface of the fibula;

and the internal, shorter and wider, also tendinous, from the posterior surface of the tibia, for about two inches below the poplitæal line, a tendinous arch uniting them to each other. A flat, thick belly now succeeds, which is fleshy much farther down than the gastrocnemius, and ultimately terminates in the tendo Achillis, by which it is attached to the os calcis.

Relations.—It is covered by the gastrocnemius, and plantaris; and lies on the deep fascia, and muscles; the posterior tibial vessels, and nerves separate the two heads, as they pass beneath the tendinous arch which connects them.

Action.—It acts on the ankle as an extensor, thus assisting the gastrocnemius.

On cutting across the plantaris, the deep fascia is seen, attached to the tibia and fibula above, and to the sheaths of those tendons which pass behind the malleoli, inferiorly; internally, it is firmly connected to the inner edge of the tibia; and externally, to the fibula; while superiorly, it is strengthened by the expansion of the semi-membranosus muscle; it is intersected by a series of fibres that run transversely, and is always much stronger below, than above, for the better protection of the posterior tibial vessels, and nerves. On removing this fascia the deep layer of muscles, four in number, is exposed, viz.,—poplitæus, flexor digitorum communis, tibialis posticus, and flexor pollicis proprius.

POPLITÆUS, lies external and posterior to the knee-joint; and arises by a strong round tendon from a horizontal groove on the external condyle of the femur, under cover of the external lateral ligament, as well as from the synovial membrane of the articulation, which connects it to the external semilunar cartilage. The tendon now divides into fasciculi, which give origin to the flat, fleshy, triangular muscle, the direction of which is downwards, backwards, and inwards, to reach an oblique line on the tibia, into which it is inserted, as well as into the bone above that line and into the fascia which covers its surface.

Relations.—It lies on the external condyle of the femur, and external semilunar cartilage, to which it is connected by synovial membrane and tendinous fibres; on the tibio-fibular articulation, and tibia; and it is covered by the external lateral ligament, tendon of the biceps. and peronæal nerve, external head of gastrocnemius and plantaris, poplitæal nerve, vein, and artery, expansion of the semimembranosus muscle, internal inferior articular artery, and inner head of the gastrocnemius. Occasionally, the poplitæal artery divides on its surface; when it will also support the anterior, and posterior, tibial arteries.

Action.—To flex the knee-joint, and rotate the leg inwards, during

flexion; or the thigh outwards, in the extended state. Its principal use, however, appears to be, to antagonise the short head of the biceps, which would otherwise have a tendency to keep the toes permanently everted.

FLEXOR DIGITORUM COMMUNIS, arises tendinous from the posterior surface of the tibia, inferior and internal to the poplitæal line, continuing to adhere to its posterior and internal surface for about six inches; and also from the interrosseous ligament, and the intermuscular septum, which separates it from the tibialis posticus; the fibres pass downwards, and become attached to a tendon that lies in the middle of the muscle, producing a penniform arrangement of the fibres; the tendon now assuming a rounded form, but still covered by a few fleshy fibres, next passes beneath the internal annular ligament, buried in a groove on the back of the internal malleolus, in company with the tibialis posticus, but each possessing its separate fibrous sheath, and bursal membrane; with this sheath continued on it, into the plantar region, it runs forwards and outwards, lying beneath the flexor pollicis, to which it is connected by a fascia, or sometimes by an obliquely defined tendinous slip; and a little more anteriorly, the outer edge having received the insertion of the musculus accessorius, it divides into four tendons, which at the metacarpo-phalangeal articulations enter an osteo-fibrous canal, similar in structure and formation to that in the hand, and likewise containing the slips of the short flexor, both being surrounded by a distinct synovial saccule; at the second phalanx, the short flexor tendons are split, the long passing through them to be inserted into the posterior edge of the ungual, or last phalanx; while those of the short, expanding on the bone, and again uniting, are inserted into the middle phalanx.

Relations.—It is covered by the deep fascia, posterior tibial vessels, and nerves, annular ligament; and in the sole of the foot, by the superficial layer of muscles, and phalangeal sheaths; it lies on the tibia, interosseous ligament, tendon of tibialis posticus, internal lateral ligament, os calcis, flexor pollicis tendon, third layer of plantar muscles, and phalanges.

Action.—To extend the ankle, and flex the toes; the latter action being the more energetic, in consequence of the penniform arrangement accumulating the muscular fibres; its obliquity in the sole of the foot, which would naturally have a tendency to overlap the toes during flexion, is counteracted by its connexion to the flexor pollicis, which passes in an opposite direction, as well as by its attachment to the musculus accessorius, which also draws it outwards.

TIBIALIS POSTICUS, arises from the inner and posterior edge of the fibula; from the outer margin of the tibia, below and external to the

soleus, and flexor communis; from the interosseous ligament, and the fascia which covers it; it passes downwards and inwards, and forms a tendon that at first runs inwards, under the flexor communis, and then appears on its inner margin, at the internal malleolus, where both are contained in the same groove and fibrous sheath; continuing its course into the sole of the foot, beneath the calcaneo-scaphoid ligament, where a sesamoid bone is usually found in its fibres, it is inserted into the tubercle, on the under surface of the navicular bone; into the internal cuneiform; and, by an external slip which passes over the two external cuneiform, into the base of the second and third metatarsal, and usually, but not always, into the cuboid bone also.

Relations.—It lies on the tibia, fibula, and interosseous ligament in the leg; and is overlapped by the flexor communis, and pollicis, and posterior tibial vessels, and nerves; while in the foot, it lies on the internal lateral ligament, in a strong fibrous sheath, beneath the calcaneo-scaphoid ligament and above the adductor pollicis; at its origin, the anterior tibial vessels run forwards between its heads; and as they do so, often carry in company with them, fibres of the muscle, through the interosseous ligament, to its anterior surface.

Action.—To extend the ankle-joint; also to turn the foot inwards, thus co-operating with the tibialis anticus.

Flexor Pollicis Longus, is the most external of the deep muscles, and also the largest and most fleshy; it arises from the two inferior thirds of the posterior and external surface of the fibula, from the septum of the tibialis posticus, and also from a fibrous layer which separates it from the peronæi; it continues fleshy as far as the ankle, and receives a slight attachment from the interosseous ligament; the tendon is at first clearly visible, at the posterior edge of the tibia, which it sometimes slightly grooves; and then enters an oblique notch, in the posterior edge of the astragalus, where it is retained by a process from the posterior division of the external lateral ligament; lastly, it grooves the inferior surface of the internal process of the os calcis (sustentaculum tali); and then running forwards and inwards, above the flexor communis, to which it is united by a slip, it passes between the heads of the short flexor of the great toe, and the two sesamoid bones, to be ultimately inserted into the posterior edge of the ungual phalanx of the great toe.

Relations.—It corresponds internally, to the tibialis posticus and peronæal vessels; externally, to the peronæi; behind, to the soleus, tendo Achillis, and fascia; and it lies on the fibula, tibia, interosseous ligament; and also on the peronæal vessels.

Action.—To flex the phalanges of the great toe; to extend the ankle-joint, and turn the foot inwards. These three tendons, of the tibialis

anticus, and of the two flexors, pass beneath a fibrous or fascial band (internal annular ligament), stretched between the internal malleolus and the os calcis; which has been fully described with the ligaments of the ankle-joint.

ANATOMY OF THE FOOT.

The fascia on the dorsum of the foot is thin, and encloses the superficial veins, and nerves in delicate sheaths; while similar funnel-shaped tubules surround the tendons, to which the fascial investment is connected by reticular areolar tissue. The superficial veins, consist of a tarsal arch, and the origins of the external and internal saphena from either of its angles. The superficial nerves, are the internal and external tarsal branches of the musculo-cutaneous, for the supply of the dorsal aspect of the toes. On removing these superficial parts, a single muscle is exposed,—the extensor digitorum brevis.

Extensor Digitorum Brevis.—Somewhat square in shape, and lying on the dorsum of the foot; arises from the triangular fossa formed by the neck of the astragalus, and upper surface of the os calcis; also from the latter bone, at the outer and anterior part of its neck; and from the dorsal aspect of the cuboid bone. It passes forwards and inwards, dividing into four fleshy bellies, to each of which a narrow tendon is attached; these pass forwards and inwards, crossing beneath the tendons of the extensor digitorum, and pollicis, at an acute angle; at the first phalanx, each is to the outer side of the corresponding long tendon, that which is destined for the great toe being the largest; they then become united with the long tendons, expand, and are inserted into the dorsal surface of the phalanges. In their distribution, the little toe receives none, while that for the great toe is inserted into the first phalanx, and not into the tendon.

Relations.—It lies on the tarsal bones, and phalanges; the internal tendon crossing the dorsalis pedis artery; and it is covered by the long extensor tendons; a large branch of the anterior tibial nerve passes through the muscle.

Action.—To extend the toes, and keep the tarsal bones in close apposition.

The integument on the sole of the foot, has been already examined; on removing this covering, and the cushion of fat lying beneath it, the os calcis and prominent points of the first and fifth metatarsal bones, and the plantar fascia are exposed; the fascia consisting of three portions,—the middle, being the strongest; the external, of mediate strength; and the internal, which lies on a plane superior to the other two, being the weakest.

Middle Portion of Plantar Fascia.—Triangular in shape,

with the apex behind, and base anteriorly, arises thick and round from the inferior part of the os calcis ; it passes forwards, expanding as it proceeds, and at the metatarso-phalangeal articulations, divides into four slips, sometimes five, which again subdivide, and arch over the flexor tendons, so as to be attached to the lateral ligaments of the joints before mentioned, throwing off transverse bands across the sulci between the toes, to form an osteo-fibrous arch for the transmission of the tendons of the lumbricales, with the digital nerves and vessels ; the anterior, or curved margin of each subdivision is also continuous with the sheaths of the flexor tendons, on the four outer toes. In the sole of the foot, the primary slips are also connected by other cross bands, dense in their character and of a silvery whiteness, which can frequently be raised as a distinct structure.

External Division, arises posteriorly, from the os calcis and sheath of the peronæi; it passes forwards, one portion being connected to the projecting point of the fifth metatarsal bone, and the other much weaker, being prolonged over the surface of the flexor brevis minimi digiti to the base of the first phalanx, to which it is attached; the external margin is continuous with the dorsal fascia ; while the internal ascends, in conjunction with the middle portion, to form a septum separating the external, from the middle set of muscles.

Internal Division of the Plantar Fascia, arises from the internal annular ligament, passes forwards, and reaching the first phalanx of the great toe, where it receives a slip from the middle division, is inserted into the sides of that articulation, the internal edge being attached to the inner side of the tarsus, while the outer sends upwards a process, which with the middle portion, forms the internal intermuscular septum. This fascia not only binds down the plantar muscles, but it also preserves the arch of the foot, which it strengthens during progression.

The muscles of the plantar region are numerous, and may be divided into four layers: the first consisting of three, viz.,—abductor pollicis, flexor digitorum brevis, and the abductor minimi digiti.

Abductor Pollicis.—Fleshy and broad behind, but tendinous in front; arises from the internal tubercle on the os calcis; and from the internal annular ligament, fascia, and intermuscular septum ; it passes forwards and inwards, and is inserted into the inner side of the base of the first phalanx of the great toe.

Relations.—It is covered by the fascia, and lies on the long flexor tendons, posterior tibial vessels and nerves, which also separate its two heads ; on the flexor pollicis brevis, and tibialis anticus tendon.

Action.—To abduct the great toe, from the mesial line of the foot.

Flexor Digitorum Brevis.—Triangular in shape, with the apex behind, and base in front; arises narrow and tendinous, from the

internal tubercle of the os calcis, internal annular ligament, fascia, and intermuscular septum; it passes forwards, becoming flat, broad, and fleshy, then divides into four slips, to which tendons corresponding in number are attached; these enter the fibrous sheaths with the long flexor tendons, and, after being split by them, are inserted into the middle phalanges of the four outer toes.

Relations.—It is covered by the fascia, and lies on the musculus accessorius, from which a thin layer of fascia separates it, on the flexor digitorum longus, and on the external plantar artery, and nerve.

Action.—To flex the toes.

Abductor Minimi Digiti.—Lies on the external side of the foot, and arises from the external tubercle on the os calcis, fascia, and intermuscular septum; also from the external thickened margin of the plantar fascia, as far forward as the metatarsal bone; it passes forwards, and is inserted into the outer side of the base of the first phalanx of the little toe.

Relations.—Inferiorly, it lies on the plantar fascia; superiorly, it corresponds to the musculus accessorius, flexor brevis minimi digiti, and bones of the little toe.

Action.—As its name implies, to abduct the little toe.

In the second layer, are found the tendons of the flexor digitorum and flexor pollicis, musculus accessorius, and lumbricales.

The Flexor Pollicis Tendon, is seen coursing forwards and inwards, and the common flexor crossing beneath it forwards and outwards at an acute angle, but both so connected that the obliquity of action liable to be produced by their direction is completely modified.

Musculus Accessorius.—A fleshy sheet; which, arises from the inferior and internal part of the os calcis, and passes obliquely downwards, forwards, and inwards, to be inserted, thin, aponeurotic, and fleshy, into the outer side of the long flexor tendons.

Relations.—It is covered by the flexor digitorum brevis, abductor minimi digiti, and the external plantar artery, and nerve; and it lies on the os calcis, and calcaneo-cuboid ligament.

Action.—To counteract the obliquity of the long flexor muscle.

Lumbricales.—Four small muscles, which arise from the internal sides of the long flexor tendons, and pass forwards and inwards, to be inserted by small, but flat bands, into the extensor tendons, on the back of the first phalanx, and also into the side of the first phalanx.

Relations.—They lie beneath the third layer, and are concealed superficially by the short flexor tendons; the tendons, at first round, pass in the intervals between the heads of the metatarsal bones, above the bridged slip of the plantar fascia, and also above the digi-

tal nerves, and vessels; they are only attached to the four outer toes, the great toe not receiving any.

Action.—To flex the first phalanx; or, according to some authorities, to extend, from being continuous with, the extensor tendons on the dorsum of the phalanges.

The muscles in the third layer, are four in number:—flexor pollicis brevis, adductor pollicis, flexor brevis minimi digiti, and transversalis pedis.

Flexor Pollicis Brevis, arises tendinous, and sometimes by two distinct heads, from the cuboid, external cuneiform, and occasionally from the under surface of the os calcis; it passes forwards, and becoming fleshy, is inserted, by two tendons, into the internal and external sesamoid bones, and base of the first phalanx of the great toe.

Relations.—It corresponds below to the abductor pollicis, and to the tendon of the long flexor; and above to the bones, and to the tibialis posticus.

Action.—To flex the first phalanx.

Adductor Pollicis.—Triangular in shape, lying external to the last; arises from the sheath of the tendon of the peronæus longus, and the base of the second, third, and fourth metatarsal bones; it passes forwards and inwards, and is inserted tendinous into the external sesamoid bone, and base of the first phalanx of the great toe.

Relations.—It has below it, the long and short flexors, lumbricales, and musculus accessorius; and superiorly, it lies on the tarsal bones.

Action.—To adduct the great toe.

Transversalis Pedis.—Placed across the heads of the metatarsal bones, arises from the anterior extremities of the outer four of those bones; passes inwards and forwards, and is inserted into the external sesamoid bone, and base of the first phalanx of the great toe.

Relations.—It is covered by the long and short flexor tendons: by the lumbricales, and the digital vessels, and nerves; it lies on the metatarsal bones, ligaments, and interossei.

Action.—To adduct the great toe, in reference to the mesial line of the foot; and to keep the metatarsal bones in apposition with each other.

Flexor Brevis Minimi Digiti, arises from the base of the fifth metatarsal bone, and the peronæal sheath; it passes forwards, and is inserted into the base of the first phalanx of the little toe.

Relations.—It corresponds superficially, to the long and short flexor tendons, external lumbricalis, abductor, and fascia; and deeply, to the bone and external interosseous muscle.

Action.—To flex the little toe.

The fourth layer, consists of the tendon of the peronæus longus, and the interossei.

The Peronæus Longus Tendon, is concealed from view by its proper sheath; this should be laid open, and the groove examined in which it lies.

Interossei.—Consist of two layers, dorsal and plantar; four in the former, and three in the latter.

Dorsal Interossei.—Arise, by a double origin, from the sides of the metatarsal bones, the two heads of the first being separated by the communicating branch of the anterior tibial artery; they pass forwards, terminating in tendons, which are inserted into the side of the base of the first phalanx, and into the extensor tendon, assisting to form the dorsal phalangeal aponeurosis; the first is inserted into the inner side of the second toe; the second, third, and fourth, into the outer side of their corresponding toes; and hence they are abductors, in reference to an imaginary line, represented by the second toe.

Plantar Interossei.—Are three in number, and arise from the inner or tibial side, and base, of the three external metatarsal bones; they pass forwards, and are inserted into the internal side of the base of the first phalanx of the three external toes, and into the extensor tendons; hence they are adductors, in reference to the same line.

Relations.—The dorsal interossei, are covered by a strong fascia, and lie on the plantar set, at their posterior extremity being perforated by small communicating arteries; the plantar, are covered by the dorsal, and lie on the long and short flexor tendons, lumbricales, and digital vessels. Their action has already been explained.

SECTION IV.

CAVITY OF THE CHEST.

The Thorax, is situated towards the superior part of the trunk, and contains the organs of circulation, and respiration; together with the several nerves, and vessels, appertaining to and connected with their functions. The walls of the cavity are yielding, to accommodate the varying increase and diminution of the lungs, but at the same time sufficiently resisting to protect them from the influence of atmospheric pressure during their active function in respiration. When the cavity is laid open, by dividing the cartilages of the ribs, and cautiously raising the sternum, a longitudinal prismatic gutter may be observed, immediately posterior to the sternum, wide superiorly and inferiorly, but constricted a little above its middle; this

space is called the *anterior mediastinum*, having received that name from its almost median position; being bounded anteriorly, by the posterior surface of the sternum, and posterior sternal aponeurosis; laterally, by the pleuræ, passing from the sternum to the anterior and lateral part of the pericardium; and posteriorly, by the pericardium itself where it is deficient of serous covering. The constriction in its middle has also given rise to its division into a superior and inferior triangle; the upper containing the remains of the thymus gland, origins of the sterno-hyoid, and thyroid muscles, with branches of the omohyoid plexus, passing downwards, to supply them, and the internal mammary artery, which borders its margins; and the lower, including the triangulares sterni muscles, rami abdominales of the internal mammary arteries, and lymphatic glands, through which pass the superficial absorbents from the liver. During life, however, the pleuræ are accurately moulded on the contained parts, so that no actual space, really exists, until the sternum is raised.

The ribs should now be sawed nearly through about their middles, and then bent backwards, when the pleural membrane, with its several inflections, should be first examined.

The PLEURÆ are two sacs of serous membrane, each being distinct and confined to a single side, and each consisting of a parietal, and a visceral layer; the former, lining and adhering to the inclosing walls; and the latter, reflected around the contained parts; one surface, which is rough and fibrous, being attached; and the other, free and smooth, and lubricated by a vapour or halitus, that is exhaled from it. The perfect continuity of the membrane, may be understood, by following its several reflections. Thus from the posterior surface of the sternum, the pleura passes backwards and inwards, to the fore-part and sides of the pericardium, thus forming the lateral boundaries of the anterior mediastinum; it is then reflected over the anterior face of the root of the lung, which conducts it to its internal or concave surface, until it reaches its thin or free edge; then over the convex surface, lining the pulmonary fissures, until the posterior or thick margin is gained, and thence to the back of the root; from this, it passes to the posterior and lateral part of the pericardium, where it is nearest to the opposite sac, and is then reflected on the sides of the bodies of the vertebræ,—here constituting the lateral wall of the posterior mediastinum; it next lines the concavities of the ribs, until it becomes continuous with the membrane where the sac was first opened; superiorly it forms a *cul de sac*, which passes higher on the right side, than on the left; while below, it covers and adheres to the superior surface of the diaphragm, forming here a fold or process connecting the diaphragmatic layer with the pulmonary, termed ligamentum latum pulmonis; this last

named fold is of an oblong figure, narrow in the middle, but wide above and below; attached superiorly, to the lower edge of the root of the lung; inferiorly, to the diaphragm; internally, to the pericardium; while externally, it is free and concave.

The PLEURA, consists of a surface-layer of squamous epithelium, supported on a fine semitransparent basement membrane, the areolar tissue subjacent to which, forms in some situations a dense fibrous layer, conferring on the pleura the compound character of a sero-fibrous tissue. As the membrane, however, differs in its characters according to its position, it will be better examined in distinct portions; thus, while the costal is strong, the serous membrane itself is thin and transparent, the strength really depending on the marked density of the fibrous layer, which adheres firmly to the costal periosteum and perichondrium; but the serous element is stronger and thicker over the intercostal muscles, to which the adhesion is slight; while on the pericardium, it is also strong; but in old subjects, the fibrous tissue is lax, and contains more or less adeps. As the pleura forms the walls of the anterior mediastinum, it is lined on its external surface, by a fascial layer, differing from the fibrous membrane heretofore described, in being weaker, and the fibrous character less appreciable; it is also distinctly laminated, and with such facility can it be separated from the serous layer that it appears to be more intimately connected to the mediastinum and pericardium, than to the pleura; and here we have distinctly traced its continuity with the fibrous tissue of the cervico-thoracic septum. The diaphragmatic portion is thin, and the fibrous layer is here represented by fine connecting areolar tissue. The cone of the pleura ascends into the neck, bounded above and before, by the subclavian artery; anteriorly, by the internal mammary; and posteriorly, by the superior intercostal; it here occupies a recess between the scaleni muscles, and is surrounded and indented by the inner margin of the first rib, to which it intimately adheres, frequently exhibiting in this situation a horizontal white line, dividing the supra-costal from the intra-thoracic portion; a strong and dense layer of fascia, derived from the prævertebral aponeurosis, here covers and adheres to its surface, protecting the lung from atmospheric pressure; this can be raised, layer after layer, by a needle, and its manifest resistance is shown by the difficulty experienced in the attempt to force a blunt instrument through its structure. The existence of this fibrous layer coating the pleura externally, explains the fact, that abscesses rarely open into the cavity of the chest, although the collection of matter may lie in immediate contact with the superficial surface of the membrane. The pulmonary portion of the pleura is fine, smooth, and perfectly transparent in the child, but often much thickened in

old subjects, and occasionally exhibiting laminated scales of bone in some situations. It is asserted that the subpleural fibrous layer is here absent; but of this we will speak presently.

The LUNGS, are symmetrical organs, communicating only through the medium of the bronchial tubes, each being somewhat conical in figure, presenting an apex, and base, two margins, and two surfaces. The apex, truncated and directed upwards, lies superiorly, between the scaleni muscles, the right however extending higher than the left, but an horizontal constriction, corresponding to the inner margin of the first rib, limits the extrathoracic portion of both below; the base, concave but more deeply so on the right side, and triangular in its outline, rests on the diaphragm; the anterior margin, thick above, but thin and interrupted below, overlaps the pericardium, and corresponds to the anterior mediastinum, that on the right side presenting two grooves, and a similar number of notches, viz., commencing at the apex, there is first an oblique groove, for the descending cava, which is directed inwards and downwards; secondly, another for the prominence of the right auricle; thirdly, a notch, the termination of the transverse fissure; and lastly, another, the termination of the great longitudinal; the left anterior edge, is interrupted from above downwards; first, near the apex, by a groove for the left subclavian artery, which is sometimes enlarged to accommodate the descending curve of the aorta; secondly, by a wide notch for the apex of the heart; and lastly, immediately above the base, by the anterior termination of the great pulmonary fissure. The posterior thick margin lies in the sulcus, between the sides of the bodies of the vertebræ, and angles of the ribs, the left being sometimes grooved longitudinally, for the descending aorta; the internal or concave surface corresponds to the pericardium, and posterior mediastinum, also to the root of the lung itself, by which the vessels enter and leave the heart, and which is situated one-third from its apex, and two-thirds from its anterior thin edge; the external surface, convex, corresponds to the concavities of the ribs, and pleura, and is deeply marked by fissures dividing the lung into lobes; the principal of these, the great pulmonary fissure, commences two inches below and behind the apex, runs downwards, forwards, and inwards, and passing through the entire thickness of the organ, terminates about one inch above and in front of the base, thus dividing both lungs into two lobes; while from the upper third of the great fissure on the right side, a second passes forwards to its root, so as to cut off a smaller middle lobe. The superior of these lobes is triangular, with the base above, and apex inferiorly; the inferior is also triangular, but the base is below, and the apex externally and superiorly; while the middle lobe of the right lung, small but of the same figure, has

the base anteriorly and the apex posteriorly. In old age, when the ribs collapse, the upper lobes descend, so as in a great measure to conceal the inferior anteriorly; in the female also, a very small portion of the inferior lobe is visible anteriorly, more especially in those cases where the chest has been disfigured by tight lacing; as under such circumstances, while the inferior lobe is pressed upwards, the superior glides downwards on its anterior surface, until it rests on the diaphragm. We have in one instance seen four lobes on each side; and three on the left in two others; in both examples the fissures, as in the normal arrangement, extended through the complete thickness of the organ, as far as the root. The uses assigned to those interruptions are, to allow the lungs to descend with greater facility as they follow the diaphragm in respiration, to isolate disease, and by the larger extent of surface exposed to the serous membrane to diminish the effects of friction. In the bird tribe, where the diaphragm is deficient, the fissures are likewise absent. The lungs present the following points of difference, when they are contrasted with each other:—the right is shorter, in consequence of the liver impinging on the right thoracic space; while the left is longer, but narrower, the deficiency in width depending upon the position of the heart; the right reaches somewhat higher in the neck, and is a little heavier than the left, presenting also under ordinary circumstances three lobes, whilst the left has only two.

The lungs are of a pale red, or rose colour in the child; grey in the adult; and dark purple, mottled with black spots, in old age; after death, they always retain a certain amount of air, which causes crepitation when their structure is compressed. The weight, in the adult, is generally from eighteen to twenty-four ounces for each organ; but it is difficult to determine even the approximate weight with any degree of exactitude, as it is influenced by the amount of blood retained after death. In the fœtus, the weight of the lungs is to that of the body as one to sixty, and after the first respiration as one to thirty, the increase depending on the admission of the blood into the pulmonary vessels. Before birth, the lung though absolutely lighter, is specifically heavier; but after birth the reverse obtains, and it is from this circumstance that the *hydrostatic test*, in cases of suspected infanticide, is of some utility in determining whether the infant was still-born or otherwise.

The structures entering into the composition of these organs, must now be examined in detail. They consist of, firstly, membranes, sero-fibrous and mucous; secondly, of the bronchial ramifications, and their terminal air-cells; thirdly, of the pulmonary arteries, and veins; fourthly, of bronchial arteries, and veins; fifthly, of areolar tissue, which forms the *parenchyma;* sixthly, of the pulmonary branches of

the pneumogastric, and sympathetic nerves; and lastly, of the lymphatic system, consisting of vessels, and glands.

SEROUS MEMBRANE.—Cruveilhier denies the existence of any fibrous tissue beneath it; but the presence of such a structure can easily be demonstrated, by making a cautious triangular incision through the pleura, and then by grasping the apex with a good forceps, and tearing it off, the friable structure of the lung will be seen to be still smooth, and covered by a glistening fibrous layer, strongest in those depressions which exist in the surface of a collapsed lung. In a case of aneurism, that exercised pressure on the root of the right lung, which was very much contracted, the fibrous membrane was exceedingly well marked; and it is also very distinct in the seal, and the otter. The use of such a structure is evidently, to prevent over-distention of the organ, and promote its contraction; while it will also prevent the contents of vomicæ being discharged into the cavity of the pleura.

ROOTS of the LUNGS.—Are fixed points, by which a communication is established between the lungs and atmosphere on the one hand and the lungs and heart on the other; they consist of the following parts—bronchial tube, pulmonary artery, and vein, bronchial arteries and veins, nerves, absorbents, and areolar tissue; each root is about two inches in vertical depth, about an inch in length, and is bounded externally, by the concave surface of the lung, which here represents a hilus, oval in shape from above downwards, for the reception of the several parts composing it; and internally and anteriorly, by the pericardium; they correspond to the fourth dorsal vertebra on the left side, and to the third on the right. The root of the right lung, is bounded above, by the curve of the vena azygos, and division of the pneumogastric nerve; below, by the ligamentum latum pulmonis; anteriorly, by the phrenic nerve, and descending cava; and posteriorly, by the vena azygos, as it ascends in the posterior mediastinum; that of the left, is bounded above, by the arch of the aorta, ductus arteriosus, left laryngeal recurrent nerve, and division of the pneumogastric nerve; inferiorly, by the ligamentum latum pulmonis; anteriorly, by the phrenic nerve; and posteriorly, by the descending aorta. By now removing the pleura from the surface of each root, it will be seen that the pulmonary veins are the most anterior and inferior on both sides; but on the right, the pulmonary artery lies above it, and most superiorly the bronchial tube; while on the left, the tube is above the vein, and below the artery, the order being from below upwards on the right side,—vein, artery, tube; and on the left in a similar direction,—vein, tube, artery; but on both, from before backwards, the order is the same,—namely, vein, artery, tube. The lung may now be raised, and drawn to the

opposite side by hooks, when, by removing the pleura, with some areolar tissue and bronchial glands, the parts constituting the roots are seen.

Bronchial Tubes.—Are continuations of the trachea, which they also resemble in structure. The trachea divides, on the body of the third dorsal vertebra, into two branches of unequal diameters (bronchial tubes), the right being the larger, shorter, and more transverse; the left longer, smaller, and more in the direction of the original trunk; the right, in its course to reach the hilus of the lung, lies on the right side of the œsophagus, crosses the vena azygos, and is covered by the pericardium, and right pulmonary artery, which separates it from the vena cava; while the left bronchus, crosses the œsophagus, and aorta, and also lies posterior to the pericardium, pulmonary veins, and artery. On entering the lung, the tubes divide each into two branches; the inferior on the right side, again subdividing for the middle, and inferior lobes; and a dichotomous division, then occurs in the substance of the organ for about fifteen repetitions, when the terminal tubes enter their proper lobules, where their ultimate ramifications are situated.

Structure of the Bronchial Tubes.—The extra-pulmonary portion, and also their divisions in the lung as far as the tertiary, present the same anatomical elements as the trachea, consisting of a series of rings, forming each about three-fourths of a circle, but incomplete posteriorly. These rings terminate in blunted points, the space between them posteriorly, being occupied from within outwards by mucous membrane, glands, elastic tissue with well-marked longitudinal fibres; and lastly, with a transverse muscular layer (Reisseissen). Subsequent to their tertiary subdivision, their structural anatomy undergoes a peculiar modification; the cartilaginous rings now completely surround the tube, but yet the circle being composed of separate segments, three or four in number, with angular or notched extremities, are united by mutual reception, but still admitting of a certain amount of overlapping, which is always more evident when the tube has been artificially contracted, by exhaustion of the air which it may contain. The muscular layer likewise assumes a circular arrangement, and the elastic tissue is also visible as elevated longitudinal fibres, while the mucous membrane is less vascular, finer, and thinner than that of the primary subdivisions of the tubes, but its surface still retains the ciliated epithelium peculiar to the respiratory mucous tissue. When the tubes reach about the fifteenth division, the cartilaginous element of their walls ceases to exist, the elastic membranous tissue being all that remains of the former structures; but as the tube still continues to divide, and as the resulting canals undergo further subdivision, each ultimately terminates in a separate air-cell, these

being distinct, and merely communicating with each other through the medium of the central tube, the whole constituting a pulmonary lobule (Reisseissen). This view has the advantage of much simplicity, and resembles the structure of the ramified secreting glands; but yet it scarcely seems consistent to believe, that where nature required to create an extensive free surface, by which the blood might come in contact with the atmosphere, a more certain means of accomplishing that object would not have occurred; and such is the fact, if the investigation of Mr. Rainey is entitled to any respect. From certain circumstances connected with the comparative anatomy of the lungs, and numerous examinations of pulmonary tissue prepared in a variety of ways, it appears to us that Mr. Rainey has approached nearer to the truth, in many respects, than any other investigator of this complex portion of structural anatomy. That the epithelium is present, even in the air-cells, is beyond question; but it certainly becomes flatter, the ciliæ being scarcely if at all perceptible; a dense membranous layer existing external to this layer, in the ultimate tubes, but without any muscular covering. Numbers of small branches proceed from the surface of the central canal, each small ramification terminating in a minute cell, whilst from its sides, columns of cells arranged eccentric to the tube, appear to form its walls; these cells communicate, the most internal with the tube, and each succeeding column with that which lies external to it; each tube, in fact with its satellite columns of air-cells, constituting a pulmonary lobule. These cells are variously figured, some being hexagonal or angular, while others are oval, or elongated in the axis of the tube. The subfibrous layer, on the pleural surface of the lung, principally consists of an elastic tissue (Gulliver), which sinks between the lobules, and then breaks up into bands or fasciculi, that wave or interlace in irregular circles around the cells, tending to preserve their expanded condition. The cells themselves, consist structurally of the fine and transparent mucous membrane on which the capillaries are expanded, with the walls thinned to such an extent, that merely the flattened epithelium separates the capillary coat from the air; and in consequence of the tenuity, and some peculiar pathological characters, the ultimate mucous lining has been conceived to be similar to a serous membrane (Stokes). The approximate diameter of each air-cell, ranges from 1-70th to 1-200th of an inch, the total number amounting to about six millions, in both lungs. The capillary vessels, are internal to the elastic bands before mentioned, and are placed between the cells, in such a manner, that both surfaces of the vessel are subjected to the influence of the atmosphere; the moist cell membrane, is in the most favourable condition for promoting the mutual interchange of elements between the inspired air and the venous blood, for the oxygen of the

former being consumed, produces by its union with the carbon resulting from the disintegrated tissues contained in the latter,—carbonic acid—which permeating the moist walls of the air-cell, escapes by the expiratory effort, while a further union of the excess of oxygen with the hydrogen of the blood, composes the pulmonary exhalation.

THE PULMONARY ARTERY, at the root of each lung, conveys the venous fluid to the capillaries, and the blood, being arterialized by the influence of respiration, is returned by the pulmonary veins, two on each side, as on the right the veins of the inferior and middle lobes uniting, make the number of these vessels similar on both sides. The right pulmonary veins, in their course to reach the left auricle, pass behind the right auricle, and ascending aorta; and in front of the spine, thoracic duct, vena azygos, and œsophagus, lying on the last at the point where they pierce the pericardium; while the left pass anterior to the bronchial tube, descending aorta, and œsophagus, and behind the left auricle, and phrenic nerve, to terminate ultimately like the right, in the posterior wall of the same cavity.

THE NERVES of the lungs, are derived from the pneumogastric, and the sympathetic; the former, at the superior margin of the root, gives off several filaments that pass to the anterior surface, beneath the curve of the vena azygos, forming the anterior pulmonary plexus, but on the posterior face of the root, the nerve becomes flattened, and lies between the serous membrane and the bronchial tubes; in this situation several branches are detached, more numerous than the anterior, to constitute the posterior pulmonary plexus, which also receives filaments from the third, fourth, and fifth thoracic ganglia of the sympathetic; and having communicated with that of the opposite side, its branches enter the substance of the lung, several pursuing the course of the pulmonary vessels; but the principal set, of both anterior and posterior divisions, follows the successive divisions of the bronchial tubes, and communicates frequently, through filaments which run between their angles of bifurcation, some disappearing on the muscular layer of the bronchi, whilst the majority can be traced even to the lobular terminations of the tubes. Those nerves exercise an important influence over the function of respiration, both in man and the lower animals, and have been frequently made the subject of experimental research. When divided, it appears from the observations of Dr. Reid that the respirations become at first hurried, but afterwards diminish in frequency; secondly, that congestion ensues; thirdly, that an effusion of frothy serum takes place into the air-cells, with exudation of blood plasma into the parenchymatous tissue, producing the second stage of pneumonia; and if the animals

survive for a period sufficiently long, purulent infiltration supervenes, and even gangrene may result, where a prolonged tolerance of the section exists, as in dogs.

Lymphatics.—Are divisible into a superficial, and a deep set of branches; the first, form on the surface, a reticulated network, with frequent varicose enlargements, and run towards the bronchial glands at the root of the lung; while the deep set are seen in the interlobular areolar tissue, also directing their course to the same place, where they communicate with the superficial division; those on the left, opening ultimately into the great thoracic duct, immediately before it leaves the chest; and those on the right, into the lesser, or right thoracic duct.

Development.—The lungs are developed, as diverticula from the œsophageal membrane, about the sixth week of intra-uterine life, the tubes consisting of a right and a left. From their surface cœcal wart-like buds sprout forth, which augment and multiply the tubules; these again, are surrounded by a parenchymatous areolar tissue, that forms the nidus for the further development of successive repetitions of the cell, and tubular elements of the lung. The pulmonary vessels ramify in the parenchyma of the cells, but as these vessels in fœtal life contain but a small amount of blood, it would seem that they merely provide for structural increase during that period, a process of growth which in after life continues until the forty-fifth year.

Posterior Mediastinum.—The student should now proceed with the examination of this space; for this purpose the right lung is to be removed at its root, and the pleura cautiously torn from the ribs and vertebræ; then, by drawing the pericardium towards the left side, retaining it in that position with hooks, and removing some areolar tissue, the parts in this region will be exposed. The posterior mediastinum is of an irregular triangular figure, extending from the third to the tenth dorsal vertebra; bounded posteriorly, by the bodies of the vertebræ, and by the anterior vaginal ligament, which clothes, their anterior surfaces; anteriorly, by the pericardium, which forms the apex of the space; and laterally, by the pleura, as it passes from the posterior and lateral part of the pericardium to the bodies of the vertebræ. Within this space, numerous parts are inclosed, supported in their position by the spinal column, and having different relations to each other, in the upper and lower division of the mediastinum. Thus on the right side are seen, the greater, and lesser splanchnic nerves; more internally, the vena azygos; still nearer to the mesial line, the thoracic duct; next in order, the aorta; after this, and to its left side, the œsophagus, with the pneumogastric nerves; next, the vena azygos minor; and lastly, the left greater, and lesser splanchnic nerves. The right intercostal arteries, with the

left intercostal veins, are also contained within its limits, but as the trachea divides at its superior boundary, it cannot properly be said to lie within the mediastinum, if accurately localized.

Splanchnic Nerves.—In connexion with these, the thoracic division of the sympathetic must be briefly noticed. It consists of a series of ganglia, twelve in number on either side, united with each other by vertical filaments, and lying on the neck of the several ribs, from which they are separated by the stellate ligaments, and covered by the pleura. Delicate filaments from the sixth, seventh, eighth, ninth, and tenth thoracic ganglia, pass downwards and inwards, forming on each side a single nerve, which opposite the tenth dorsal vertebra having pierced each its corresponding crus of the diaphragm (the left however occasionally passing through the aortic opening), and entered the abdomen, they form the semilunar ganglia, from which is derived the solar plexus. The lesser splanchnic are likewise constituted by fine filaments from the tenth and eleventh thoracic ganglia; and they, on piercing the diaphragm, form in the abdomen, the renal plexuses.

Vena Azygos, arises in the abdomen, from the ascending lumbar loops, which surround the transverse processes of the vertebræ in that region; it passes upwards, through the aortic opening on the right side of the aorta, and the thoracic duct; and ascending on the right side of the posterior mediastinum, at the fourth dorsal vertebra, curves forwards over the root of the lung, to enter the descending cava, as that vessel is about to perforate the pericardium, about one inch above its termination. In this course it receives the bronchial, œsophageal, and intercostal veins, and is destitute of valves.

Thoracic Duct, about the size of a goose-quill when distended, commences in the cavity of the abdomen from a dilated reservoir—the receptaculum chyli, which is situated on the right side of the body of the second, or third lumbar vertebra, posterior and to the right side of the aorta; it then ascends through the aortic opening, between the aorta, and the vena azygos, and entering the posterior mediastinum, becomes posterior to the œsophagus; opposite the fourth dorsal vertebra, it runs behind the left extremity of the transverse portion of the arch of the aorta, and then behind the origin of the left subclavian artery; and still higher up, it occupies a space, bounded internally, by the left carotid, and trachea; externally, by the subclavian; posteriorly, by the œsophagus; and in front, by the left vena innominata; having ascended through this space, as high as the sixth cervical vertebra, it curves downwards behind the jugular vein, and pneumogastric nerve, crossing over the longus colli, sympathetic nerve, inferior thyroid, and vertebral arteries, and then turning inwards, in front of the subclavian artery, opens into the subclavian vein just where it

unites with the jugular to form the left vena innominata. (See LYMPHATIC SYSTEM.)

ŒSOPHAGUS.—A musculo-membranous tube, commencing at the termination of the pharynx, opposite the body of the fifth cervical vertebra, and extending to the cardiac orifice of the stomach, or a point corresponding to the eleventh dorsal vertebra, should be examined successively in the neck, thorax and abdomen. In the cervical region, at its commencement, it lies nearly in the mesial line, and is connected by its longitudinal muscular fibres to a vertical ridge on the back part of the cricoid cartilage. The mucous membrane from the pharynx passing downwards to line its internal surface, and the inferior constrictor, surrounding its external aspect, tend to produce a perfect continuity between the canals. In this part of its course, the direction of the œsophagus is downwards and to the left, and it is visible on that side of the trachea, at the upper margin of the sternum.

Relations.—In front, it has the trachea, and the recurrent nerves; laterally, the thyroid body, inferior thyroid arteries, the carotids, particularly that of the left side, and the thoracic duct; while posteriorly, it lies on the prævertebral fascia, which separates it from the longi colli muscles. On entering the thorax, the tube again approaches the middle line, and passes behind the arch of the aorta, but the trachea intervenes between them in this position. On the left side, it supports the left carotid artery; and opposite the third dorsal vertebra, lies on the right side of the descending aorta, crossed in this situation by the left bronchus, left pulmonary artery, and veins, and is supported by the spine; it now gradually alters its position, from right to left, running in front of the thoracic aorta, and behind the pericardium; then passes through the œsophageal opening in the diaphragm, anterior and to the left side of the aorta, and enters the cavity of the abdomen. In the posterior mediastinum, the pneumogastric nerves are attached to its surface, the left vagus, lying anterior and to the left side; and the right, to the posterior and right side; these, closely interlacing and uniting by cross or oblique branches, constitute the plexus galæ. The œsophagus, having entered the cavity of the abdomen, should now be examined in that situation; this may be accomplished by raising the left lobe, and left lateral ligament of the liver, which form its anterior relations; while posteriorly, it corresponds to the left crus of the diaphragm, left phrenic artery, and occasionally to the semilunar ganglion of the sympathetic. The abdominal portion of the tube is from half-an-inch to one inch and a half in length, and becomes dilated as it enters the stomach, midway between the splenic end and lesser curvature, but a little nearer to the former. When the

stomach is distended, it forms a very obtuse angle with the lesser curvature, and one equally acute with the great end; but these angles are always less evident, when the organ is in a collapsed condition, than when distended. The pneumogastric nerves still preserve a similar relation to the tube, but in addition to the left, we also find the ascending branch of the coronaria ventriculi lying on its internal and anterior part.

Structure of the Œsophagus.—It consists of four coats,—fibrous, muscular, submucous, and mucous.

Fibrous Coat, is well marked after the middle periods of life, and is always present, forming a complete investment for the tube in its whole extent, and although semi-transparent, its strength is very great, particularly in the mediastinal portion of the tube, where it serves to prevent over-distention, and preserves the relation of the muscular fibres to each other.

Muscular Coat, consists of two planes, longitudinal and circular; the former, being external, and extending from the ridge on the posterior surface of the cricoid cartilage as far as the stomach, where they become continuous with the muscular layer of that organ; while the latter, form a well-marked layer, likewise continuous with the circular fibres of the stomach. In their course downwards, an alteration is manifest in their character, when structurally examined, the muscular fibres being red in colour in the upper third of the tube, and evidently striped, but in the two inferior thirds they become paler, the striæ gradually disappearing, and exhibiting all the usual characteristics of involuntary muscles. It will be here observed, that the œsophageal muscular tunic constitutes an example of the insensible transition, from the voluntary to the involuntary class of muscular fibre.

Submucous Coat.—Composed of dense unyielding fibrous tissue; continuous above, with that of the pharynx; and below, with that of the stomach.

Mucous Membrane.—Thick and pale, forming a marked contrast in colour, with the gastric and pharyngeal portions; its external surface is rough, and adheres intimately to the submucous coat; while the internal is wrinkled, and presents from ten to fifteen longitudinal plicæ or folds, which terminate at the cardiac orifice of the stomach in projecting fringes or festoons; a dense epithelium, by some described as a cuticular layer, covers the entire of its free aspect; this can be raised, by subjecting the membrane to the action of an acid; it appears to terminate in the festoons at the cardiac orifice; but this is really not the case, as it is continued throughout the whole alimentary canal, although with decidedly altered anatomical characters. The mucous membrane of the œsophagus, is remarkable for want of sensibility to ordinary impressions.

Organization or Vascular Supply, is derived from the inferior thyroid arteries in the neck, aorta in the thorax, and coronaria ventriculi in the abdomen. The veins, open into the inferior thyroid, mammary, cava, and azygos; and in the abdomen, into the gastric, and phrenic. The lymphatics, communicate with glands which surround the tube. The nerves, are derived from the pneumogastric.

Use.—To transmit, by its peristaltic action, the food to the stomach.

The THORACIC AORTA, commences opposite to the lower edge of the body of the third dorsal vertebra, almost in the mesial line, and descends on the left side of the spine to the tenth dorsal, where, again inclining towards its anterior surface, it enters the aortic canal, to become abdominal. For particular anatomy of this vessel, see VASCULAR SYSTEM.

VENA AZYGOS MINOR.—Not always present; but when it is so, commences in the abdomen from the ascending lumbar vein of the left side, and having pierced the left crus, enters the posterior mediastinum, where it receives the five inferior intercostal veins, and, then crossing the spine opposite the sixth dorsal vertebra, behind the aorta, opens into the great azygos.

The left greater, and lesser splanchnic nerves, are similar to those on the right side.

TRACHEA.—Opportunity may now be taken for examining the trachea or air-tube; this operation will be facilitated by drawing the heart and pericardium towards the left side, when by removing any areolar tissue and glands between the trachea and the aorta, its course will be sufficienty exposed. It commences at the lower margin of the cricoid cartilage, and descends with a slight obliquity towards the right side, as low as the third dorsal vertebra, where it bifurcates into the right and left bronchi.

Relations.—It lies on the œsophagus, and right longus colli; and is covered anteriorly, by the middle lobe of the thyroid body, descending thyroid veins, middle thyroid artery, when such a branch exists, sterno-thyroid and hyoid muscles, left vena innominata, arteria innominata, left carotid, remains of thymus gland, transverse portion of the arch of the aorta, descending cava, and superior part of the pericardium; while it corresponds on each side to the inferior laryngeal nerves, which lie in a groove between it and the œsophagus, inferior thyroid arteries, and the lateral lobes of the thyroid body, with the carotids, and arteria innominata.

Structure.—It consists of from seventeen to twenty-one rings, each forming about three-fourths of a circle, or rather of an oval. The free extremities may terminate in different ways, being either blunted, incurvated downwards, or expanded; while the upper and lower edges are thin and beveled off, giving attachment to the interannu-

lar elastic ligaments which connect them to each other. The first and last rings, however, present some peculiarities; the former being sometimes complete, and united to the cricoid cartilage, into which it ascends during expiration, in the generality of instances, and as life advances, partakes in those structural ossific changes, to which the laryngeal cartilages are all so prone. This perfect annular condition is natural in the bird tribe; as well as its osseous condition, which may extend even to the fourth ring. The last ring is triangular, with the base above, and apex inferiorly, corresponding to the angle of bifurcation; the base superiorly, being connected to the penultimate cartilage, while the lateral margins are cut off obliquely downwards and inwards, so as to present an aspect directed downwards and outwards, to which the primary rings of the bronchi are attached. We have sometimes, seen this cartilage divided into two lateral, and a middle prismatic portion, as if it was the type of a compound structure, composed of three minor rings; but it has never appeared to us, as a perfect circle, or even the seat of osseous deposits; the existence of such a form and structure, being rather drawn from analogy than founded on observation; and when we reflect on the peculiar function performed by the inferior larynx in birds, as a producer and a modulator of sounds, and then contrast it with the bifurcation of the human trachea, and the offices it sustains, we at once become cognizant of the necessity for a dense and sonorous material in the former, and the inutility of a similar structure in the latter. The posterior surface of the trachea, for about one-fourth, is composed of several structures; thus, from within outwards we observe, firstly, mucous membrane; secondly, tracheal glands; thirdly, elastic tissue; and fourthly, transverse muscular fibres (Reisseissen), covered by lax areolar tissue.

Mucous Membrane, is pale and thin on the surface of the cartilaginous rings, but thicker and of a rose colour in the intervals between them, and is with difficulty removed from the subjacent parts; the epithelial covering belongs to the ciliated variety.

Elastic Layer.—Through the mucous layer, the elastic tissue appears, consisting of vertical fibres in front and laterally, interrupted by their attachment to the rings, but forming posteriorly a continuous, well-marked layer, separated from the mucous lining by a stratum of mucous glands about the size of millet seeds, which open on the free surface of the trachea.

Muscular Layer.—The muscular fibres which form the fourth layer, are confined to the intervals between the rings behind; they commence posteriorly, beneath the cricoid cartilages, and are continued down to the bronchial tubes; their direction being transverse, and the extremities attached to the terminal points of the

tracheal rings; but we have also seen them continued for a short distance on their surfaces, as if exhibiting a tendency to that arrangement, which is normal in the smaller bronchial tubes. They belong to the involuntary or non-striped system, their use appearing to be, that of diminishing the diameter of the trachea; the elastic fibres, having a similar effect, on the length of the tube. They no doubt exercise a considerable influence, in the production of spasmodic diseases of the air passages; and indeed, in several cases, where the subject had died labouring under chronic bronchitis, we have seen them nearly equalling in thickness, similar muscles of an ox. The contraction of the trachea and bronchial tubes, has been observed by Dr. Williams, under the influence of direct stimulation; as well as by Longet and Volkman, on acting through the medium of the vagi. The *vascular supply* is derived from the inferior thyroid, internal mammary, and bronchial arteries; and the *nervous* from the recurrent, laryngeal, and pulmonary plexus of the vagi, with branches from the great cardiac plexus of the sympathetic.

Development.—It is formed as a membranous tube, by an offset from the œsophageal membrane, which at first communicates with the gullet, like the air-duct in some fishes; the rings appearing primarily as mere specks, then gradually expanding laterally, and holding the same relation, in size, to the diameter of the small fœtal trachea of the ninth month, that they bear to the adult tube.

Middle Mediastinum.—The student may now examine this space; which contains the heart, and pericardium, with the great vessels, entering, and issuing from that organ; its general relations being, in front, the anterior mediastinum; behind, the posterior; and laterally, the lungs.

The Pericardium, which contains the heart and great vessels, is a sero-fibro-serous sac, conical in shape, with the base below, attached to the diaphragm at its central tendinous portion, and to the fleshy fibres of the left side for a short extent; from the former it may be detached in the fœtus as a distinct layer; but in the adult, while the adhesion is rather intimate posteriorly, it is quite inseparable anteriorly, or towards the sternum; the apex superiorly, is prolonged on the great vessels, becoming continuous with the fascia of the neck; laterally, it corresponds to the concave surfaces of the lungs and their roots, with the phrenic nerves; in front, to the sternum, from which, however, it is separated by cellular tissue; and on the left side, to the cartilages of the fifth, sixth, and sometimes seventh rib, but with the intervention of the left lung, which, being notched at its thin anterior border, permits a portion of the pericardium to become superficial, in the space between the fifth and sixth ribs; while posteriorly, it is related to the posterior mediastinum and its contents.

The PERICARDIUM consists of three distinct structures; first, a *serous* layer, derived from the pleura, which forms only a partial investment, being deficient in a narrow space, anteriorly and posteriorly; also at the base, where the fibrous layer is attached to the diaphragm, as well as in those positions where vessels enter and leave. The *fibrous* layer, which is thin but remarkably strong, is attached by its superficial surface to the pleura, but rather loosely, especially anteriorly and in old subjects, owing to some fat intervening between them; while by its deep surface, it is intimately connected with the internal serous lining. In the adult, nine perforations occur in its structure,—one for the aorta, two for the cavæ, a similar number for the right and left pulmonary arteries, and four for the pulmonary veins, an additional one existing in the fœtus, for the ductus arteriosus; but all these openings are undefined, in consequence of a process from the sac being prolonged on the coats of each, as it enters or emerges. If the sac is now laid open, by a crucial incision on the anterior surface, we will find that it presents internally a smooth and glistening surface, from being lined by a proper *serous* layer, which, like other membranes of the same class, forms a shut sac, and consists of a parietal, and a visceral portion, with a perfect continuity of structure subsisting between them. This membrane may be traced upwards on the posterior surface of the anterior wall of the fibrous pericardium, from which it is reflected on the three great vessels at the base of the heart, inclosing the aorta, and pulmonary artery in a common sheath, which is complete anteriorly and posteriorly; but deficient where those vessels are in contact, a circumstance explained by the fact, that they originally formed but a single trunk, the subsequent development of the septal wall producing the division into the distinct aorta, and pulmonary artery, from an inch and a half to two inches of both vessels being inclosed within the serous sheath. The superior cava, is covered only on the anterior and right side, but not posteriorly; and this investment only extends for one inch on the vessel, or to that point where the vena azygos opens into its cavity. From the vessels, the serous membrane may now be carried over the anterior surface of the heart down to its apex, and round that point to its posterior surface, covering the inferior cava, and the pulmonary veins, on the anterior and lateral surfaces, but not posteriorly; then up to the posterior surface of the aorta, and pulmonary artery; from this to the pericardium, and round its posterior part to the base, and ultimately to the anterior surface, the point where the description commenced. Three saccules are also seen within the pericardium; one corresponding to the space behind the aorta, and pulmonary artery, transversely oval; the second, placed behind the left auricle; and the third, in the situation occupied by the apex of the heart.

The pericardium fixes the heart, on which it is accurately moulded, and by the serous lining facilitates its motion during the conditions of contraction, and dilatation, *systole*, and *diastole*.

The Vascular Supply, is derived from the internal mammary artery; and the Nervous, from the phrenics, and left laryngeal recurrent.

When the pericardium is fully laid open by a crucial incision, the following parts are brought into view,—superiorly, vena cava to the right side, pulmonary artery to the left, and aorta in the middle; lower down, the right auricle, with its appendix, and appendix of left auricle; still lower, right ventricle, and that portion of the left which constitutes the apex of the heart, with the coronary vessels ramifying in the interventricular sulcus; and when the heart is lifted from its position, and thrown to the right side, the posterior surface of the left ventricle, and both auricles, with the pulmonary veins, and inferior cava, are brought into view.

The Heart, which should now be examined, is a muscular organ contained within the pericardium, and consists of four cavities, namely,—two auricles, and two ventricles, the former occupying the superior portion of the organ, and the latter the inferior. It is of a triangular figure, with the base above, and apex below, but situated obliquely, so that its axis would be represented by a line passing from the interval between the first and second rib, posteriorly and superiorly downwards, forwards, and towards the left side, or to the space between the fifth and sixth ribs, on the left side of the sternum; the right margin of the sternum, the whole width of that bone, and the cartilages of the third, fourth, and fifth ribs of the left side lie immediately in front of it, and the bodies of the fifth, sixth, and seventh dorsal vertebræ posterior to it. Owing to its configuration, it has been likewise subdivided into sides, with a single auricle and ventricle appertaining to each; but although in the lower animals these may be correctly described as right and left, in man, while a similar nomenclature has been adopted, it is certainly inaccurate, and should be consequently abandoned, as the cavities lie rather anterior and posterior, the one being identical with the right, and the other with the left side of the older authors. However, we prefer to adopt the names derived from the functions which each performs; and thus, the right or anterior side, inasmuch as it propels the venous blood through the vascular system of the lungs, should be called the pulmonary, or venous chamber; while the left or posterior side, that urges the blood through the whole arterial system, should be described as the systemic, or arterial. As the heart lies obliquely within the pericardium, it presents three surfaces and two edges: the anterior surface, convex and triangular, looks

forwards, and is marked by a vertical sulcus, which divides it into two unequal portions; three-fourths being constituted by the right ventricle, and the remainder by the left. The posterior and inferior surface, resting on the cordiform tendon of the diaphragm, is flat, and also divided by a continuation of the same sulcus; but here the relations as to size are reversed, the left ventricle forming three-fourths of its extent, and the right the remainder. The third surface corresponds to the base of the ventricular portion of the heart, looks upwards, backwards, and towards the right side, and is surrounded by a sulcus which marks the limit between the auricles and ventricles; this sulcus contains some fat, with the coronary vessels, and is deceptive in appearance, as to depth; but by removing the fat, the muscular fibres of the ventricles are seen to turn inwards as far as the auricular tendinous rings, an arrangement more obvious posteriorly than anteriorly. The right edge, thin and sharp, convex superiorly, but straight inferiorly, rests on the diaphragm; while the left, exceedingly thick, round, and convex, and almost perpendicular, is lodged in a concavity of the left lung, of course with the intervention of the pericardium. Attached to the base of the ventricles, are two vessels, and two cavities; of the former the pulmonary arterial zone is the more anterior, and the aortic, the more posterior, and a little to the left side; whilst the auricular rings occupy a still more posterior plane, and are moulded on the back part and sides of the aortic zone. The base of the ventricles presents an oblique plane, being cut off from above, downwards, and backwards, so that the anterior surface of the heart exceeds the posterior in length by nearly an inch and a quarter; but although this disparity apparently exists in the surfaces, we will find hereafter that both ventricles are nearly of equal extent, in the vertical direction. The two cavities constituting the auricular portion of the organ, and situated on the back part of the ventricular base, are of an hour-glass figure, with the anterior surfaces prominent on each side, but excavated in the middle, the excavation corresponding to the posterior part of the aorta, and pulmonary artery; the right and left auricular appendices are also visible; they are, long, narrow, muscular cylinders, serrated at their margins, placed anteriorly on the right side, but situated more posteriorly on the left; the former, resting against the side of the aorta, and cava; and the latter, against that of the pulmonary artery; the posterior surface of the auricles, convex, and marked by a vertical sulcus continuous with that between the ventricles, indicates the situation of the septum auricularum, on the left side of which are seen the termination of the four pulmonary veins; and on the right, the two cavæ, and the great coronary vein; the auricles rest posteriorly on the œsophagus, aorta, and spine. The weight of the heart, in the adult, averages from seven to eight ounces.

In the adult, the blood takes the following course in its pulmonary, and systemic circulation :—It is first collected by the superior, and inferior cavæ, and great coronary veins, and poured into the right auricle, from which it is urged into the right ventricle, through the right auriculo-ventricular opening ; from this it is propelled through the pulmonary artery ; and, having traversed the pulmonary capillaries, where it undergoes the requisite change from venous to arterial, it is returned by the pulmonary veins to the left auricle ; then, through the left auriculo-ventricular opening, into the left ventricle, from which cavity it issues, by the aorta, to ramify through the entire arterial system.

Right Auricle.—Is of a crescentic figure, with its flattened margin inferiorly at the auriculo-ventricular opening. In order to examine its cavity, an incision should be made on its right wall, from the superior cava to a quarter of an inch above the inferior, and a second carried from the middle of the first, towards the right auriculo-ventricular opening ; the flaps may then be reflected, and the cavity sponged out, so as to remove any coagulated blood that might obscure the several parts on its walls. The openings into the right auricle, are seven in number—namely, superior, and inferior cavæ ; auriculo-ventricular ; coronary veins, one, two, or three in number ; a small aperture at the superior part of the fossa ovalis ; the opening of communication between the appendix, and sinus of the auricle ; and lastly, a number of small openings (foramina Thebesii), which are seen principally on the posterior wall.

Superior Cava.—At the highest point of the posterior wall of the right auricle, is observed the opening of the superior cava ; this vessel, formed by the confluence of the right, and left venæ innominatæ, commences at the upper margin of the cartilage of the second rib, on the right side ; it passes downwards, inwards, and a little forwards, pierces the pericardium obliquely, and reaches the posterior and superior part of the auricle, into which it opens. The auricular orifice of this vein, looks a little backwards and inwards, and is circular and smooth ; a perfect continuity subsists between the fibrous wall of the vein, and the areolo-fibrous subserous layer of the auricle ; and in addition, the serous membrane on the external surface of the heart, is reflected over the anterior and right side of the vein, while the lining membrane (*endocardium*) of the auricle, which likewise belongs to the class of serous membranes, is protracted into the venous cylinder.

Tubercle of Lower.—Beneath the opening of the superior cava, a projecting lip of thickened muscular tissue is generally observed, but occasionally it may be absent ; it is called tuberculum Loweri, and forms the line of separation between the two caval openings. Various explanations have been given, to account for the

projection of the auricular wall in this situation; by some, it has been attributed to the meeting of the currents of blood, entering from the superior, and inferior cavæ; by others, to the passage of the right pulmonary veins behind the auricular wall forcing it into the interior of the cavity; and by others again, to the existence of a portion of fat, very frequently observed in this situation, particularly in old subjects.

Inferior Cava.—Beneath the tubercle, is the inferior caval orifice, circular in figure, and much larger than the superior; this vein commences on the right side of the body of the fifth lumbar vertebra, by the confluence of the common iliacs; and in its course upwards on the right side of the spine, receives the lumbar, right spermatic, renal, and hepatic veins; it then passes through the tendinous quadrilateral opening in the diaphragm, and, entering the pericardium, bends almost horizontally towards the left side, opening into the posterior and inferior part of the right auricle, so near the corresponding aperture of the superior cava, that their posterior walls seem to be continuous.

Eustachian Valve.—In connexion with the last-described opening it will be convenient to examine the Eustachian valve, a structure which in the adult subject is merely rudimentary, presenting in the majority of cases, a reticulated and imperfect appearance; semilunar in figure, and composed of a duplicature of the serous endocardium, it is placed above, in front, and to the right side of the caval orifice, and offers for description a concave, and a convex margin; and a superior, and an inferior cornu. The concave edge is free, and looks upwards, backwards, and to the right side; while the convex, directed downwards, is attached to a horizontal groove between the caval orifice and the anterior wall of the auricle; the superior cornu, narrow and prolonged, is connected to the anterior or left lip of the fossa ovalis, and is sometimes continued, round that depression, to the posterior lip; while the inferior, wider than the superior, is united to the anterior edge of the inferior cava, with the lining membrane of which vessel, it is perfectly continuous. This valve is only of use in fœtal life, for the purpose of directing the current from the cava into the left auricle through the foramen ovale; but as we will again recur to this subject, when speaking of the foramen Botalli, we for the present refrain from further noticing it.

Coronary Vein.—Inferior and to the left side of the caval opening, the auricle presents a triangular facette, strongly marked with reticulated muscular fibres, and at the deepest part of the depression a small valve (valvula Thebesii) indicates the position of the orifice of the coronary vein, which lies at the posterior and inferior part of the auricle. The coronary veins, consist of a greater and a lesser;

the former, commencing in the anterior interventricular furrow, above the apex of the heart; it at first ascends, and then turns backwards, and towards the left side, between the left auricle and ventricle, to the posterior part; here it receives a branch from the posterior interventricular furrow, and becomes expanded into the great coronary venous sinus; ultimately the continued trunk pierces the posterior wall of the auricle, in which it terminates. The valve situated at the orifice is often absent, and always imperfect; nor can it be of much utility in preventing regurgitation, because the opening, being situated in a muscular part of the auricle, the contraction of the surrounding fibres must necessarily prevent the passage of the blood backwards during the systole of that cavity. The existence of the sinus is by some physiologists believed to favour the opinion of systolic regurgitation; but this dilatation serves merely as a reservoir for the venous blood during the contraction of the auricle. The smaller coronary veins are three or four in number, and open into the anterior and inferior part of the auricle.

Right Auriculo-Ventricular Opening.—Immediately superior to the opening of the coronary vein, is the auriculo-ventricular opening, which forms the communication between the right auricle and right ventricle; it is of an oval figure, with the long axis from above and behind, downwards and forwards, and is one inch and a quarter in its antero-posterior measurement, and one inch in the transverse; its margin, round and smooth, exhibits a dull, white colour in consequence of the tendinous auricular zone which surrounds it, being here merely covered by serous membrane; this zone is placed in this situation, not only for the purpose of preventing distention of the opening, but likewise to keep it patulous and at the same time afford origin to the tricuspid valves.

Fossa Ovalis.—On the *septum auricularum*, we observe the vestige of a fœtal opening represented by the fossa ovalis; this is most frequently seen as a depression, surrounded by an incomplete annulus, and the appearance which it presents, may be either membranous and smooth, or covered by a stratum of muscular tissue, closing the original aperture like a plug; or the surface may be invested by reticulated muscular columns; or lastly, there may be a single fleshy column at its inferior segment, which is then likewise attached to the Eustachian valve. The annulus ovalis consists of a fleshy lip, surrounding three-fourths of the fossa, but it is deficient posteriorly and inferiorly; of its two pillars or limbi, one is placed anterior and to the left side, the other posterior and to the right; and if a probe is passed beneath the upper concave edge connecting the two, a small oblique aperture will be discovered, in the generality of instances, forming a communication between the auricles; the peculiar valvular

arrangement, however, obviating any attempt at admixture of the fluids contained in the right and left cavities. In fœtal life the blood passed directly through this space, which was then patent, into the left auricle, the Eustachian valve prolonging the tube of the cava upwards, towards that point—in fact forming its anterior wall. It has been latterly stated that the Eustachian valve is at its highest pitch of development at about the third month of intra-uterine life; but this is quite incorrect, as it never diminishes during any period of fœtal life, its growth being continuous up to the ninth month, a condition perfectly consistent with, and necessary for, the functions it is called on to perform. The mechanism by which the closure of the *fossa ovalis*, or foramen of Botal, is accomplished may be thus explained :—from the posterior and inferior part of its circumference, a semilunar fold of membrane projects at the fourth month of fœtal existence, and in many cases a distinct muscular stratum contained within this duplicature of the endocardium is distinctly visible ; as gestation advances, this valve (operculum foraminis ovalis) increases, until it attains sufficient magnitude to occlude the opening perfectly ; but still, being placed on the left side of the foramen, it allows the current to pass from right to left, while it presents an effectual barrier to its passage in a contrary direction. The patency however of the inter-auricular septum after birth, constitutes merely a solitary link in the chain of pathological conditions, that produce the affection known as cyanosis. (See Dr. Mayne's paper in the *Dublin Quarterly Journal*, Feb. 1848.)

Auricular Appendix.—A fleshy saccule, shaped like the ear of a dog, and springing from the anterior and superior surface, varies in length from three quarters of an inch to an inch and a quarter, its calibre being sufficient to admit the introduction of one of the four inner fingers ; it is curved forwards and inwards, so as partially to conceal the superior cava, and aorta ; its margins are notched and serrated, externally ; while internally, the surface is reticulated, fine muscular fibres crossing it in every direction, often so loosely attached that a probe can be passed beneath them with facility ; it communicates with the auricle, by a circular constricted orifice ; and from this, in addition to the muscular fibres already described, others, round and semi-attached, run downwards on the side of the superior cava, as low as the auriculo-ventricular opening ; these fibres, from their peculiar form and appearance, have been named musculi pectinati. Several uses have been assigned to the auricular appendix—Thus, by some it is supposed to be placed there, for the purpose of blending together by its contractions, the chyle and venous blood ; by others that it is the true auricle itself, that which is generally described as such being nothing more than a mere dilatation, formed

on the two cavæ; by others again, that the first contraction of the chamber begins at this point, and is thence gradually propagated to the adjacent parts; and still by others, with much more reason, that its object appears to be to form a reservoir for the overplus of blood in periods of temporary distention.

Foramina Thebesii.—Are a number of small openings, principally seen on the superior and posterior wall of the auricle; they have at different times been conceived to be the orifices, not only of the small veins of Vieussens, but likewise those of the lymphatics of the heart; but without any foundation, as they are merely involutions of its lining membrane.

In order to dissect the right ventricle, the anterior wall of the cavity should be raised, from below to within half-an-inch of the auriculo-ventricular groove; and this should be done, by keeping the edge of the knife close to the septum on either side. This chamber in shape is found to be triangular, with the base above, and apex below, and terminates about three quarters of an inch above the point of the heart. Within the cavity are seen the following parts: Carneæ columnæ, chordæ tendineæ, tricuspid valves, auriculo-ventricular opening, and the origin of the pulmonary artery.

Carneæ Columnæ.—Are smooth, fleshy bands, on the internal surface of the ventricle, and consist of three sets: the first, which are the most numerous, are attached by their extremities but free in the middle; they cross the surface, in every conceivable direction, producing that reticulated appearance, described as the cavernous structure of the right ventricle—a character more evident on the anterior wall, and apex, than on the septum; the second set, larger, flatter, and less numerous, are attached to the wall of the ventricle by one surface, in its whole extent, and these we have seen most frequently on the septum; whilst a flat, strong band (moderator), described by Mr. T. W. King, also passes backwards, and towards the right side, to be attached in front to the anterior, and behind to the septal, wall of the cavity. It will be observed, that this muscular fasciculus not only keeps the anterior wall in contact with the septum, mechanically preventing over-distention, but likewise urges the blood by its contraction into the arterial outlet; the third set of fleshy columns are called musculi papillares, and these are wide, thick, and exceedingly strong; they are attached by one extremity to the wall of the ventricle, and by the other to the chordæ tendineæ, which again connect them to the back, and to the free margins, of the valves.

Chordæ Tendineæ.—Are fine, threadlike fibres, white, glistening, and silvery in appearance, and surrounded by a serous layer; they are attached by one extremity to the fleshy columns, and by

the other to the margins of the valves, and are prolonged on their external surface as far as the auricular opening; but occasionally, we have seen muscular fibres continued on the surface of the cords as far as their valvular attachment.

Tricuspid Valves.—Three in number, situated within the ventricle, and formed by a double layer of the serous lining of the heart with an intervening fibrous stratum; of these, one is anterior, and to the right side; the second, posterior; and the third, to the left side; each valve presents either a quadrilateral, or an irregularly triangular figure with two margins, and an equal number of surfaces; the superior margin being attached to the auricular tendinous zone, from which a process is continued, between the folds of serous tissue that compose it; while the inferior is comparatively free, and receives the attachment of the chordæ tendineæ, which are connected not only to the edge, but are also continued on the external surface of the valve, as far as its attachment. In addition to several other carneæ columnæ in connection with them, both the right and the left valve are attached to a thick fleshy fasciculus called the moderator band, which connects the anterior and posterior walls of the ventricle; while the posterior valve, the smallest of the three, is attached to the septal wall by chordæ tendineæ only, and hence, is more or less passive, in its action. The left valve, is generally described as separating the auricular and arterial openings (septum of Lieutaud), and so preventing the escape of the blood into the pulmonary artery, until the ventricle is fully distended; but this assertion is not to be received; firstly, because a distance greater than the length of the valve intervenes between the openings; secondly, because the pulmonary artery is in its systolic movement, with the semilunar valves thrown down, when the ventricle is in the act of being filled; and thirdly, the wide portion of the valve does not separate the openings, but is much more anterior, only the narrow posterior edge intervening between them. Mr. King has attributed a very important function to the anterior valves, both left and right; for as they are attached by their free margins to the anterior or movable wall of the ventricle, it follows, that during excessive distention they are prevented from accurately closing the auricular opening, and thus, by permitting some regurgitation, naturally obviate that paralysis which should necessarily result from over-distention.

The Pulmonary Artery.—Arises from the anterior superior and left side of the base of the right ventricle, which is prolonged upwards at this point, under the name of the infundibuliform process, or the arterial portion of the ventricle. It is usual to describe the inner surface of this tubule, as smooth; but that character is only present on the septal part; while anteriorly, it is marked by reticulated

fibres. The infundibulum, is separated from the auricular opening by a thick, tumid lip of muscular tissue, with its concavity directed downwards; and from the aortic opening, by the superior part of the septum, which is depressed but strong; while, occasionally, a congenital deficieucy may exist in this situation, allowing the pulmonary artery, and aorta, to communicate, and thus becomiug a cause of *cyanosis;* superiorly, the infundibulum terminates in a tendinous anuulus, to the upper edge of which the pulmonary artery is attached by three convex roots, composed of the fibrous coat of the vessel, which is implanted into the tendiuous ring, while in return, the triangular processes of the ring are prolouged iuto the spaces between the roots; the liuing membrane of the heart is also continued iuto the vessel, forming at its orifice, with a thin layer of fibrous tissue interposed, three semilunar, or sigmoid, valves, which are attached by their convexities to the margins of the roots; while the concavities are free, and look from the heart, each contaiuing in the centre a small nodule of fibrous tissue (corpus Arantii, vel sesamoideum). To those Arantiau bodies, which are also found more highly developed in the semilunar valves of the aorta, several uses have beeu assigned; namely, to keep the valve apart from the wall of the vessel, so that duriug its coutraction, the blood may insinuate itself with greater ease, between it and the valve; to close a small triangular space that exists when the valves are opposed, and to confer on them increased strength aud resistauce. The valves are composed of a replication or fold of the serous endocardium, with an intervening fibrous layer derived from the teudinous riug; aud their use is to prevent reflux of blood from the artery, into the ventricle, an action which is purely mechanical. The pulmonary artery passes at first upwards and forwards, theu backwards aud towards the left side, curving round the anterior and left side of the aorta, and after a course of about two iuches, divides into a right and a left brauch, of which, one passes to each lung, in which they agaiu subdivide repeatedly, and in binary order, uutil the air cells are reached, when the requisite change having taken place in the blood which they contain, it is takeu up by the pulmouary veius, to be carried back to the left auricle. As the pulmouary artery ascends, it is covered in front by the serous layer of the pericardium, which serves to connect it to the aorta, aud here a deficiency may also exist betweeu the two vessels uear their roots, somewhat similar in arrangemeut to the same part in the Crocodilus Lucius, aud constituting another pathological conditiou of cyanosis.

Left Auricle, placed on a plane posterior, inferior, and to the left side of the right, is somewhat of a cuboid figure, and correspouds behind to the pulmonary veins; superiorly and posteriorly,

to the auricular appendix; anteriorly, and on the right side, to the septum, and groove for the aorta, and pulmonary artery; and inferiorly, to the auriculo-ventricular opening, with the circular furrow containing the left coronary artery, and the great coronary vein. It appears smaller than the right, and its coats are also thicker, and deeper in colour. In order to expose its cavity, an incision should be made vertically on the anterior wall, between the appendix (at its root) and the aorta; a second of smaller extent carried backwards and towards the left side, will lay it sufficiently open for all practical purposes; on its walls, when properly cleaned, will be observed seven openings, namely:—the openings of the four pulmonary veins; orifice of the appendix; oblique aperture at the summit of the fossa ovalis; and lastly, the auriculo-ventricular opening.

Pulmonary Veins, are four in number, two for each lung; those for the right consist at first of three trunks, corresponding to the superior, middle, and inferior lobes; but the superior, and middle unite after a short course, so that at the root of the lung there are only two: from either side they pass towards the mesial line, and having pierced the pericardium on the anterior surface, and received a covering of serous membrane from its lining, they enter the posterior and inferior part of the auricle. Those on the left side, while outside the pericardium, lie on the left bronchus; and within that bag on the descending aorta; while those of the right, rest on the right pulmonary artery and œsophagus, and are behind the descending cava, right auricle, and descending aorta. These veins do not possess valves, and at their auricular extremities, a mutual interchange of anatomical elements occurs, the muscular tissue of the auricle being prolonged on that portion of the vessels within the pericardium, whilst the venous structure enters into the formation of the auricular walls. On the septum auricularum, which is convex in this cavity, the small oblique communication between the auricles is generally observed, but without any annulus, as in the right. The opening of the appendix, which is longer and narrower than that of the right side, is small and circular, leading into a conical cavity, in which the muscular fibres are badly marked, and the margin, very closely serrated, curves forwards, so as to overlap the pulmonary artery, and aorta, although its root is at the upper and back part of the auricle. The left auriculo-ventricular opening, slightly oval in shape, with the long measurement transversely but one-third smaller than that on the right side, and, like it, surrounded by a tendinous zone, leads directly into the left ventricle.

The Left Ventricle, may be exposed by raising the septum ventriculorum, from apex to base; and in general terms, it may be said

that this cavity is conical in shape, but projecting for fully half an inch below the right, so as to form the apex of the heart; while superiorly, the right ascends for some distance above it. The walls of the left ventricle are much thicker than those of the right, and within its cavity we observe carneæ columnæ, chordæ tendineæ, mitral valves, and auriculo-ventricular orifice, with the origin of the aorta.

The CARNEÆ COLUMNÆ are arranged in a manner precisely similar to those in the right, but those attached to the tendinous threads of the mitral valves are usually only two in number, and are round and thick, where they arise from the ventricular wall, but digitate or divided at the point of connexion with the tendons; the reticulated fibres are few, in comparison with those on the right side, and do not produce that peculiar cavernous structure so remarkable in the latter.

The SEPTUM, which is really a part of this cavity, is concave, and somewhat smooth, the fleshy bands which lie on its surface being flat, and attached by their whole extent.

The MITRAL VALVES, are two in number; one being placed anteriorly, and the other posteriorly; the anterior, the larger, is attached to the anterior half segment of the auricular zone, and separates the aortic from the auriculo-ventricular opening, about two lines intervening between them; while the posterior, smaller and more fixed, is connected above to the posterior half segment of the auricular zone; the inferior margins, of both right and left, receiving the attachment of numerous chordæ tendineæ. These valves, particularly the anterior, are much stronger than the tricuspid, and are also more calculated accurately to close the mitral opening, so as to prevent regurgitation, but their structure and mode of formation, are precisely similar in their character.

The AORTA, arises from the superior, anterior, and right side of the base of the left ventricle, which appears to be divided by the anterior mitral valve into two portions—an anterior or arterial, and a posterior or auricular portion. The arterial portion is bounded anteriorly and to the right side, by the septum, which in this situation presents a smooth surface; posteriorly and to the left side, by the anterior mitral valve; and superiorly, by the aortic tendinous annulus. This ring receives externally and inferiorly, the ventricular muscular fibres; while superiorly, it presents three concavities, corresponding to the convex roots of the aorta, which are connected to three triangular elevations, occupying the spaces between them. This opening, like that of the pulmonary artery, presents three semilunar valves, for the purpose of obviating regurgitation, but these will be more fully described with the arch of the aorta (See ARTERIAL SYSTEM).

The MUSCULAR TISSUE of the HEART, appertains to the involuntary system, and although wholly removed from the control of volition, it still presents some peculiarities which seem to ally it in structure to the voluntary system; thus, it is thick, firm, and resisting, of a deep red colour, with the fibres presenting a feeble striation, and attached to tendinous tissue. These peculiarities, though they cannot influence the volitional effect, may provide in a great measure for that energetic action, which the heart exhibits in a much greater degree, than any other muscle of the involuntary class. These muscular fibres may be divided into an auricular, and a ventricular system; in order to examine them effectually, it will be necessary to fill the heart's cavities with plaster of Paris, and then, by carefully removing the serous membrane, the proper tissue is exposed, which may now be unravelled. We have been enabled to demonstrate the cardiac fibres exceedingly well, by selecting the heart of an infant, and subjecting it to maceration in a solution of corrosive sublimate and alum, which hardens the muscular fibre; and at the same time renders the separation of the layers extremely easy. This we prefer to boiling, a proceeding which produces so great a friability of the fibre, that it becomes almost impossible to preserve the specimen entire, even for a short period.

The AURICULAR FIBRES, consist of a superficial, and a deep set,—the former, being common to both cavities; while the latter, being distinct appendages to a single auricle, are hence called "proper." The common fibres, cover the anterior face of both cavities, and the auricular appendices, then sink posteriorly into the median furrow, but do not pass into the septum; they are strong anteriorly, and present an excavation for the aorta, to which they are attached by areolar tissue. Many deficiencies occur in this stratum, where vessels enter and leave, particularly posteriorly; and although it is commonly stated that these fibres arise from the auricular, and aortic zones, dissection into the auriculo-ventricular furrow will exhibit the intervention of the ventricular fibres, and so demonstrate the fallacy of this view. The proper auricular fibres, are attached to the deep and upper edge of the auricular rings, and are thicker in the left than the right auricle; in the left, they assume a circular arrangement; but in the right, they cross in all directions, and present at many points a well-marked reticulated appearance.

The SEPTAL WALL, convex towards the left, and concave towards the right side, consists of two muscular planes, that of the left auricle being smooth; whilst that of the right, forms by a sudden increase in thickness, the incomplete annulus which surrounds the fossa ovalis. By a careful dissection, carried through the septum, the right may be separated from the left auricle, that portion which is proper to the right cavity being much the thicker of the two.

Ventricular Fibres, consist of a double set, like those of the auricles; and when the serous layer of the pericardium is removed from the ventricles, the most superficial common fibres are observed descending from the auricular zones downwards, forwards, and towards the apex, or from right to left on the anterior surface; and on the posterior part, running obliquely from left to right, in order to reach the same point. In this situation, we observe an anterior and a posterior band which wind round each other, producing a stellate disposition at the apex, where they dip into the interior of the ventricles, to form the inner wall of those cavities; and ascend to be attached to the deep surface, and inner edge, of the tendinous zones. Thus the superficial surface of each ventricular wall, and also the deep, are constituted of common fibres; while the proper are situated in the interval between them; the proper consist of a muscular sac for each ventricle of a conical shape, with the base attached superiorly, to the auricular zones; and with the apex inferiorly, presenting a small aperture, through which the common fibres gain access to the internal cavities.

Three distinct layers of muscular fibres have been described in the right ventricle, and six in the left; but instead of tracing these individually, it will simplify the subject in some degree, to state, that on the external surface of the ventricles, the common fibres, or, more correctly speaking, bands, assume three forms,—the first, passing obliquely from apex to base; the second, surrounding both ventricles; and the third describing a double circle, investing each cavity, and preserving their continuity through the septum. The internal common fibres, also admit of a three-fold arrangement; of these the first are looped, passing from the superficial to the deep surface; the second, spiral; and the third, are a diminutive representation of the last, being turned on themselves like the figure of eight, to form the carneæ columnæ. The proper fibres are rather spiral or circular; they cross each other at very acute angles, and are most visible in the vicinity of the apex.

The Septum, consists of three layers, two of which belong to the right ventricle, and one to the left—those cavities by division of the superficial common fibres, being capable of being separated exactly as in the case of the auricles. It must, however, be borne in mind that in the foregoing account we have merely given a general description of the muscular structure of the heart, as being the only mode applicable to the intricacy of the subject, in a condensed work of this nature; indeed a sharp knife, scissors, and a pair of needles, will yield, to any patient investigator, conditions adapted to any description, however complex; and this should be regarded as a circumstance perfectly natural, when we recollect that the fibres are united, not by areolar tissue, as in other situations, but by a mutual

interweaving, which renders the structure almost inextricable. (See Searle, in *Todd's Encyclopædia*, page 168).

Development of the Heart.—This organ at its earliest period is visible as a pulsatile speck, the "punctum saliens of Harvey;" and first consists of a single tube formed in the vascular layer of the germinal membrane, receiving the veins at its posterior extremity, while the arteries emanate from its anterior; subsequently, it becomes curved into a loop, presenting three saccules; arterial, or ventricular; venous, or auricular; and the bulbus aortæ, a dilatation at the extremity of that vessel. About the fourth week, the septum ventriculorum commences to be developed from below upwards, or from apex to base, and is completed about the eighth; while the septum auricularum is developed from the superior and anterior part, but remains deficient at the foramen ovale until birth. The Eustachian valve is an early structural formation, being sufficient at the third month to conceal the inferior caval orifice, and at this period the proper valve, or membrane, of the foramen (valvula Botalli) becomes visible, and it is stated that now the valves grow in an inverse ratio, or that the Eustachian diminishes, as the septal increases. We have before stated that such a change is functionally impossible, nor has such a law ever been satisfactorily proved by the only unerring test—demonstration. The heart occupies the whole cavity of the thorax in the fœtus, about the fourth week of intra-uterine life, and is much larger, in proportion to the weight of the body, at the third month than at birth, its weight being to the body, at the former period, as 1 to 60, at the latter as 1 to 120. It is also vertical, the obliquity of direction commencing about the fourth month; while, in addition, the apex is double, both ventricles conspiring to its formation; and the disparity between the auricles and ventricles is much more marked than in the adult, the left side being more capacious than the right, for obvious reasons.

The action of the heart is, to propel the blood through the vascular system, exercising a pressure on that fluid equivalent to a weight of four pounds three ounces. The external manifestations of its contractions consist of an impulse, a first sound followed by a second, and lastly, by an interval. The impulse caused by the apex of the heart striking against the space between the cartilages of the fifth and sixth ribs, occurs during the systole or contraction of the ventricles, and has been attributed to several causes, namely, to the propulsion of the blood into the curved arch of the aorta, which induces a consequent tendency in that tube to assume the straight position, and so tilts forwards the apex of the heart (Hunter, Senac); and also to the fact, that the posterior fibres of the right ventricle are shorter than the anterior, and the latter, con-

tracting one-third of their length, curve the apex forwards; while it has likewise been accounted for, by the spiral direction of the fibres, as well as by the dilatation of the ventricles. The first sound is somewhat dull and prolonged, and is conceived by some to arise from the sudden tension of the mitral and tricuspid valves (Dr. Billing); by others it is believed, that it is produced by the contraction of the ventricles (Williams), regarding it as a muscular sound; and by others, again, to the rush of the blood over the roughened walls of the ventricles, but it appears more rational to suppose that it is produced by all those causes in combination. The second sound, more sharp and abrupt in its character, is caused by the flapping of the aortic valves, aided of course by those of the pulmonary artery, and this has been placed beyond the possibility of dispute by positive experiments (Dublin Committee, Hope). Supposing that the period occupied by the first and second sounds, with the interval, is represented by the number four, the first sound would occupy two, and the second and the interval one each. The heart at each contraction propels from one ounce and a half to two ounces and a half into the systemic circulation, so that taking the whole mass of blood as being on an average about twenty-eight pounds, it would pass through the heart in a period of from three to four minutes; or if the quantity be taken at the moderate estimate of sixteen pounds, in a minute and a half, but the rapidity of the contraction of the organ will materially affect this estimate, and it is on this account necessary to become acquainted with the variations, which are mainly influenced by the period of life. Thus the pulse averages:—

	BEATS IN A MINUTE.		
In the fœtus in utero,	140	to	150
Newly-born infant,	130	—	140
During the first year,	115	—	130
——— second year,	100	—	115
——— third year,	90	—	100
About the seventh year,	85	—	90
Age of puberty,	80	—	85
Manhood,	70	—	80
Old age,	50	—	65

The pulse of the adult female, exceeds that of the male, by from ten to fourteen beats in a minute (*Carpenter's Physiology*).

The parts which occupy the superior aperture of the chest, should be examined, if possible, in a fresh subject, thus:—The skin and fascia should be removed from the neck, and the internal third of the clavicles and first ribs, corresponding to the division of the former bones, sawn through, as it is presumed that the second bone of the sternum has been previously thrown upwards, for the injection of the subject; the latter bone, with the sections of the clavicles,

and first ribs should now be raised as one piece, which will carry up the sterno-mastoid, hyoid, and thyroid muscles attached to it; and these can again be replaced or removed at various periods, so that the student may become familiar with the relative position of the superficial muscles and bones, to the subjacent vessels and nerves; and we would particularly impress on him the importance of attentive study of this region, the patient investigation of its contents being of paramount interest, not only to the anatomist, but also to the surgeon. In the first instance, we observe the deep cervical fascia, firmly attached to the interclavicular ligament, as it stretches between the thorax and neck (cervico-thoracic septum), and then descending on the posterior surface of the sternum as the posterior sternal aponeurosis, of which it forms only a part; posterior to this, the sterno-hyoid ascends, converging towards its fellow, and deeper still and wider than the last, the sterno-thyroid diverging. On the posterior surface of these muscles, branches of the omohyoid plexus descend, to supply their origins, each being invested by a thin layer of fascia; and beneath these again, the left and right venæ innominatæ are disclosed; the former, being from two and a half to three inches in length; and the latter, from one inch and a half to two inches; both commence opposite to the sterno-clavicular articulation by the union of the left jugular and subclavian veins, the left passing obliquely towards the right side, and the right nearly vertically downwards, to form the descending cava, by their confluence at the upper edge of the cartilage of the second rib. The left, in this course, presents a curve, with the concavity looking upwards and backwards, and crosses the following parts, from left to right:—Left internal mammary artery, and phrenic nerve, left pneumogastric nerve, subclavian artery, thoracic duct, left carotid, arch of the aorta to which it is also superior, cardiac nerves, trachea, arteria innominata, and right pneumogastric nerve; while the parts superficial to it are, the left sterno-clavicular articulation, sternum, sterno-hyoid, and thyroid muscles, and the remains of the thymus gland, with a layer of fascia which not only covers it, but likewise connects it to the aorta, and ultimately becomes continuous with the fibrous layer of the pericardium. In its passage across, it receives a number of branches,—namely, the descending thyroid, sometimes the left vertebral, and superior intercostal, with the internal mammary vein of the left side. The right, on the other hand, in its course downwards and inwards, to reach the left at the origin of the cava, corresponds on the right side, to the lung, pleura, and phrenic nerve; on the left, to the pneumogastric nerve, and to the arteria innominata; anteriorly, it is covered by the sterno-clavicular articulation, and cartilage of the first rib, and by the remains of the thymus gland;

while posteriorly, it rests on the right wall of the anterior mediastinum, and the pneumogastric nerve, which is at first internal, and subsequently behind it; this vein is smaller than that of the left side, and occasionally the vertebral and right inferior thyroid veins open into its termination. Behind those venous trunks, the arteria innominata is seen ascending upwards, forwards, and towards the right side, and appearing above the sterno-clavicular articulation, about half an inch from the surface; and a little to its left side, the left carotid, supported by the trachea; and still more to the same side, the subclavian is observed ascending, but on a plane posterior to it, while between the carotid, and arteria innominata, the trachea passes downwards, and towards the right side, lying behind the left vena innominata, and arch of the aorta. The right phrenic nerve enters the chest, passing between the subclavian vein and artery; but the right pneumogastric, is always found between the right vena innominata and subclavian artery, crossing the latter vessel at right angles; on the left side it is parallel, but anterior to it; both phrenics lie at first external, then anterior, and finally internal to the internal mammary artery, this vessel on both sides being covered by the corresponding venæ innominatæ, as they enter the chest. By now drawing the left carotid towards the right side, in the groove between the œsophagus and trachea, the left recurrent nerve is seen ascending, a little external to it the thoracic duct, and lying on the œsophagus internal to the left subclavian artery. The cardiac branches of the sympathetic nerves are circumstanced differently on the right, and on the left side; for on the right they cross the subclavian artery, and arteria innominata; while on the left, with the exception of the inferior, which passes behind that vessel (subclavian on left side), they run in the groove between the left carotid, and subclavian arteries. In a depression, between the transverse process of the seventh cervical vertebra and the neck of the first rib, and internal to the vertebral artery, the inferior cervical ganglion is wedged, and from it a thick cord descends into the chest, to communicate with the first thoracic ganglion of the sympathetic; still more posteriorly, the superior intercostal branch of the subclavian enters the cavity in front of the neck of the first rib; and behind this, the dorso-brachial nerve winds upwards and outwards, to reach the brachial plexus; while lastly, on the front of the spine, the longi colli muscles pass upwards from their origins, with the anterior vaginal ligament descending between them, clothing the anterior surface of the spine. All those parts will be found fully described with their proper systems.

Thymus Gland.—In concluding the anatomy of the chest, we must allude briefly to a temporary organ,—the thymus gland, and as it is

peculiar to fœtal life and infancy, it will be necessary for the student to obtain a very young subject, for its examination. The gland consists of two symmetrical triangular lobes, united in the mesial line by areolar tissue, but otherwise perfectly distinct, forming a mass of a pyramidal figure, which has the base below, corresponding to the fourth rib, and the apex above, attached to the thyroid body. The posterior surface rests on the pericardium, phrenic nerves, left vena innominata, arch of the aorta, arteria innominata, left carotid, and pneumogastric nerve, on the trachea, descending thyroid veins, and middle thyroid arteries; while it is covered anteriorly, by the sternum, cartilages of the first, second, third, and fourth ribs, by the deep cervical fascia, and sterno-hyoid and thyroid muscles.

At the third month of fœtal life this organ is small, but gradually increases until the eighth, when it becomes suddenly augmented in size, so that at birth it weighs about 240 grains, or half an ounce; its growth further continuing to progress until the termination of the first year. Each lobe contains a cavity, but partially separated into a cervical and a thoracic saccule by a constriction; the cervical being superior, and the smaller of the two; the thoracic, inferior and the larger. These cavities are lined by a vascular mucous membrane, and filled with a whitish fluid like chyle, with a few red corpuscles.

Structure.—It consists of a number of follicles, ranging in size from a pin's head to a small pea, each possessing distinct fibrous walls. They are usually globular, or polygonal in figure; and in all cases, are surrounded by a delicate plexus of blood-vessels, which, with fibrous tissue, forms the medium of connexion with other lobules; their cavities are lined by a prolongation of the general cavitary membrane, and while some communicate with the central reservoirs, others coalesce, and afterwards terminate in the same general receptacle, their orifices being strewed over the internal surface, where a layer of ligamentous bands surrounds them, throwing the lining membrane into ridges or folds. When the gland is unravelled by dissection, after being macerated for a short time, each lobe can be drawn out into a straight tube, with the follicles attached to it in a spiral manner. This gland is without any special duct, and may therefore be classed with those of the vascular kind, connected with the lymphatic system. The arteries which supply its structure are derived from the internal mammary, and thyroid; while the efferent veins open into the left vena innominata, and thyroid veins. The lymphatics communicate with the junction of the jugular and subclavian veins, and Sir A. Cooper believes them to be the ducts of the gland. The nervous supply is principally derived from the sympathetic system, but we have observed a branch from the left phrenic

also entering its structure. The uses of this organ, are involved in obscurity. Sir A. Cooper thinks that it is connected with the elaboration of a fœtal blood, from the more vitalized fluid of the mother; while Hewson believed, it was the organ from which the nuclei of the blood corpuscles were eliminated.

CAVITY OF THE ABDOMEN.

Having examined the several structures constituting the abdominal wall, and removed the muscles, the contents of the cavity may be exposed by dividing the peritonæum vertically, from the ensiform cartilage to the symphysis pubis, keeping, however, a little to the left of the mesial line; and intersecting this, by another incision carried horizontally across, an inch or so below the umbilicus, and terminating on each side, at the outer border of the quadratus lumborum. The four flaps thus formed may now be everted, and the following parts will be brought into view;—above, and to the right side, the anterior edge of the liver, with the gall-bladder protruding from beneath it; in the middle, and to the left, the anterior face of the stomach; below these, the ascending and transverse portions of the colon, the great omentum, and small intestines; and lower still, the cœcum, sigmoid flexure, and bladder if distended.

Before entering into a description of the individual parts that are found in the abdominal cavity, it will be necessary to take a slight view of the peritonæum, and explain the relation which it holds to the several viscera, both hollow and solid, and how by its peculiar inflections it envelopes some only partially, while again, it affords to others a covering which might be said to be all but complete.

The PERITONÆUM, the most extensive serous membrane in the whole body, forms a closed sac, the anterior part of which, is intimately attached to the abdominal walls in front, and laterally; whilst its posterior, much larger and looser, is folded around the several viscera, which by this arrangement are seen to be completely external to its cavity. In following out its several reflections, it is a matter perfectly unimportant where it is commenced; but as the umbilicus has been hitherto assumed as the starting-point, we will adopt the same system, and trace it through its tortuous course, until it is again brought back, to the same place from which we set out.

The incisions already made clearly expose the peritonæum passing upwards, lining the whole of the anterior and lateral walls of the abdomen, and continuing its course backwards to cover the concave surface of the diaphragm, as far back as the thick margin of the liver. As it proceeds in this direction it meets with the umbilical

vein, around which it forms a falciform fold, which on reaching the liver, spreads out and becomes continuous with the serous covering of that viscus. From the under surface, and posterior part of the diaphragm, it is now inflected downwards, to the upper surface of the liver, near its thick border; and passing forwards over its convexity, it reaches its anterior margin, around which it sweeps to cover in its inferior surface, as far as the transverse fissure, where its further progress is impeded by the vessels which enter at that part. In order to cover in that portion of the liver that lies behind the fissure, we must now assume a process, that we will presently again account for, sweeping from its thick margin forwards, as far again as the transverse fissure; thus producing at this point two layers of the membrane, one in front and one behind the depression or cleft; these now pass downwards, separated from each other however, by the vessels of the liver, till they reach the concave margin of the stomach, the portion between these two viscera constituting the gastro-hepatic, or *lesser omentum.* At the upper edge of the stomach, they diverge to inclose that viscus, but they again unite at its convex margin, and proceed downwards as a double layer, free and floating in front of the hollow intestines, until they arrive at the lower part of abdomen, where they are suddenly inflected upwards and backwards on themselves, thus forming four layers, called the *great omentum.* As they now continue their course upwards and backwards, they meet with the transverse colon, to inclose which they split; and again uniting, pass upwards and backwards to the spine, where they constitute the *transverse mesocolon.* At the spine, they are again divided by the inferior transverse portion of the duodenum, which crosses the vertebral column at this point; and here one layer proceeds directly upwards, forming the ascending layer of the transverse mesocolon, which partially invests the first and second portions of the duodenum, the aorta, pancreas, and cava, until it reaches the back part of the diaphragm, from which it is inflected on the under surface of the liver as far as the transverse fissure, being identical, in fact, at this point with the process which we assumed as constituting the posterior layer of the lesser omentum. Returning now to the second portion of the transverse mesocolon, called its descending layer, we will find that it is attached to the left side of the body of the second lumbar vertebra and to the right ilio-sacral symphysis, forming the root of the mesentery, from which processes are sent out which nearly encircle the small intestines, called the *mesentery;* folds are likewise prolonged into the lumbar regions, binding down and partially covering the ascending and descending colons, termed the right and left lumbar *mesocolons;* as well as others, into the iliac regions, to the cœcum, and sigmoid flexure, which they likewise in-

completely invest—the first being called the mesocœcum, but the other has received no definite name. If we now turn the small intestines to the right side, we may observe the descending layer of the transverse mesocolon sweeping downwards over the bifurcation of the aorta, until it meets with the rectum, which it completely envelopes for its upper third—the meso-rectum; but as it sinks into the pelvis it gradually abandons the rectum, covering the sides and front only of its middle third, from which it is reflected on the under and back part of the bladder, leaving between it and the rectum a deep depression, termed the recto-vesical pouch. Ascending now, over the posterior surface of the bladder, it invests it for about one-third of its entire extent, till it arrives at its superior fundus, where it meets with the urachus, and obliterated hypogastric arteries; and guided upwards by them along the anterior wall of the abdomen, it reaches the umbilicus, the point from which it was originally commenced.

The peritonæum, which we have just described, forms ligaments for the liver, bladder, and uterus, which will be more properly described in the separate review of each of those viscera. We therefore, for the present, confine ourselves to the consideration of the several processes which it constitutes, as it pursues its intricate course through the abdominal cavity.

Gastro-hepatic or Lesser Omentum.—This essentially consists of a double fold, between the layers of which run the ductus communis choledochus, vena portæ, and hepatic artery, with branches of the pneumogastric and sympathetic nerves. The formation of this process is explained in the following manner:—The layer of serous membrane reflected from the diaphragm, on the upper surface of the liver, having passed around its anterior edge to its under surface, is arrested in its further progress, on reaching its transverse fissure, by the parts entering and leaving it. It is accordingly inflected round them externally, when a large fold is thrust in behind the stomach, covering in its posterior surface, and forming as it descends the posterior layer of the great omentum. At the inferior margin of this process it turns upwards, and constitutes the anterior part of the transverse mesocolon, which, on reaching the spine, ascends over the posterior wall of the abdomen as far as the liver, which it covers inferiorly, behind the transverse fissure, thus forming a continuous pouch or sac within the great sac of the peritonæum, its boundaries being the following:—Anteriorly, the lesser omentum, stomach, and great omentum; inferiorly, the great omentum turning upwards on itself; posteriorly, the transverse colon, and the ascending layers of the transverse mesocolon; and superiorly, the transverse fissure of the liver. The interval through which this secondary

sac is thrust in, was first described by Winslow, and hence it has always been called after him, and described as the foramen Winslowi. This opening is bounded in front, by the lesser omentum, and the parts contained in it; behind, by the ascending layer of the transverse mesocolon; below, by the superior horizontal portion of the duodenum, and hepatic artery; and above, by the lobulus Spigelii of the liver. If the finger is kept close to the back part of the lesser omentum, it will pass into the sac, and can be freely moved in the large space behind the stomach.

Splenic Omentum.—This is a double fold of the peritonæum, prolonged from the inferior surface of the diaphragm, and completely invests the spleen, except at the hilus, where the vessels enter for its supply. From this point it is reflected to the right side, where it becomes continuous with that portion covering the stomach, to which it is thus closely united, and necessarily also with the arch of the colon, through the ascending layer of the transverse mesocolon.

Great Omentum.—In early life, this process is exceedingly circumscribed, and sometimes does not exist at all; but it becomes gradually developed with advancing years, so as to reach from the lower margin of the stomach as far as the brim of the pelvis, being generally found to be a little lower on the left than the right side, thus accounting for the more frequent existence of epiplocele in the latter situation. It usually covers the mass of the small intestines like an apron, but it may be occasionally coiled up amongst them, or sometimes adherent to them, so as to require the connexions to be broken up before it can be properly seen. It presents various appearances in different individuals, being in some thin and diaphanous, whilst in others it is much more opaque, and thicker to the touch, from the fat deposited between its layers. Glands likewise exist in this situation, and it is traversed by several branches of arteries derived from the epiploic, and superior mesenteric. It forms the bond of union between the stomach and colon, suspending the arch of the colon, and maintaining it in its normal position.

The great omentum is also called the *Epiploön*, whence a hernia formed by it is termed *Epiplocele*.

Transverse Mesocolon, is merely the continuation, backwards and upwards, of the two reflected layers of the great omentum, which, after embracing the arch of the colon, pass backwards from it to the spinal column. We have already remarked, how the two layers are again separated at the spine, by the inferior transverse portion of the duodenum; the one called the ascending layer of the transverse mesocolon, passing upwards, and binding down the several parts in connexion with the posterior wall of the abdominal cavity, and consti-

tuting the posterior boundary of the great *cul de sac* of the peritonæum, which is thrust in through the foramen of Winslow; while the other, called the descending layer of the transverse mesocolon, runs downwards to form several processes which we have yet to describe.

Mesentery, is one of the most important inflections of the whole serous sac, as it contributes in a great degree to maintaining the small intestines in their normal position. It is attached to the left side of the second lumbar vertebra, from which it passes downwards, and to the right iliac fossa, where it becomes continuous with the serous membrane of that region. From the oblique line which it thus forms, it is reflected at first downwards, so as to cover the anterior surface of the whole of the small intestines; and then, sweeping below and behind them, again ascends to re-unite with the layer in front, thus enveloping their whole circumference, except superiorly and posteriorly, where a narrow portion is left uncovered, corresponding to the entrance of the arteries and emergence of the veins and lacteals. The mesentery extends, from the commencement of the jejunum, to the termination of the ileum; and the two layers of which it is composed, are separated by numerous branches derived from the superior mesenteric artery; as well as by glands, and lacteals, in their course to reach the receptaculum chyli.

Lumbar Mesocolons, are lateral processes derived from the last mentioned, which are thrown over, and partially invest the ascending and descending colons, keeping them fixed, in the right and left lumbar regions. In their course outwards, they likewise cover the anterior surface of the kidneys.

Mesocœcum, and Ileo-Mesocolon.—Both these processes, the one partially investing the cœcum, and the other the sigmoid flexure, are continuations downwards of the mesocolons of either side; but that for the sigmoid flexure is always the more perfect, constituting a species of mesentery, for this portion of the gut. The vermiform appendix, which is attached to the inner and posterior part of the cœcum, is very variable with respect to its peritoneal connection, being sometimes tensely bound down by it to the wall of the pelvis, while often it is sufficiently loose to allow it to float freely in that cavity.

Mesorectum, forms, as we have already stated, a perfect covering for the upper third of the rectum, but is deficient posteriorly on its middle third, which it invests only laterally and anteriorly, and from which it is reflected forwards on the back part of the bladder, leaving its inferior third completely uncovered. The partial envelope which it affords to the bladder, has been already fully described in the anatomy of that viscus; we will therefore only observe here, that in the male subject a large *cul de sac* is left

between it and the rectum, with its sides prominent, owing to the passage of the ureters, which are included within its folds; and in this space, in the undistended condition of the bladder, is contained a great part of the small intestines. From the existence of the uterus in the female, it necessarily results that two such *cul de sacs* must occur,—one, the larger of the two, situated between the front of the rectum and the back part of the vagina and uterus; and the secoud, much the smaller, between the front of the uterus and the back of the bladder. In the case of the female, likewise, two broad folds stretch from the sides of the uterus to the corresponding iliac fossæ, termed the broad ligaments, which contain within their folds the round ligament of the uterus, ovaries, and Fallopian tubes.

Structure.—The peritonæum, like the pleura, consists of a superficial layer of pavement epithelium, supported by a basement membrane, with a subjacent stratum of areolar tissue, containiug numerous elastic fibres. Its vascular supply is limited, while its nervous organization has not hitherto been clearly demonstrated, although, when the seat of iuflammation, the manifestations of pain are of a most poignant character.

Uses.—To connect the several viscera contained within the cavity, and also to facilitate their movements on each other.

The cavity of the abdomen contains essentially, the organs devoted to digestion, secretion, and excretion. To simplify description, they may be divided into the hollow or membranous, and the solid or glandular—the first, consisting of the stomach; duodenum, jejunum, aud ileum; cœcum, ascending, transverse, and descending colons, with its sigmoid flexure; and the rectum; the second comprising the liver, spleen, pancreas, and kidneys. We will commence our description with the

Stomach.—This hollow viscus, truly a dilatation of the œsophagus, is in the human subject a flattened cone, with the larger extremity directed towards the left side, and the smaller towards the right, where it becomes continuous at the pylorus with the duodenum. It occupies nearly the entire of the epigastric, and left hypochondriac regions, and presents, for the purposes of description, an anterior and a posterior surface; a superior, and an inferior margin; a right, and a left extremity; a cardiac, and a pyloric orifice. The anterior surface, looks forwards and upwards, and is in relation with the diaphragm, abdominal walls, and left lobe of the liver, which overlaps it to a very variable extent; while the posterior, directed downwards and backwards, corresponds to the sac of the omentum, and ascending layer of the transverse mesocolon, which separates it from the inferior transverse portion of the duodenum, pancreas, crura of the diaphragm, psoæ muscles, aorta, and several of its branches. The superior edge,

turned upwards and backwards, is short and concave, except towards its pyloric extremity, where it is slightly convex; it corresponds to the lesser omentum, and the coronary and pyloric arteries, which are contained within its folds; while the inferior, directed downwards and forwards, is much longer than the superior, and convex except at its smaller extremity, where a slight concavity exists, corresponding to the convexity on its upper edge; it is in contact with the great omentum, and the arch of the epiploic arteries. The left extremity, rounded and capacious, and forming a large part of the entire organ, corresponds to the spleen, diaphragm, and cartilages of the four or five inferior ribs; while the pyloric, small and constricted, becomes continuous directly with the duodenum, the point where this union takes place being variable, generally occupying a position between the horizontal fissure of the liver and the gall bladder; but the line of demarcation between the two, is always better marked and defined by a dense ring,—the pylorus, which sinks in and contracts the orifice of communication between them. A little to the left side of the pylorus, there is a partial dilatation on the stomach, particularly perceptible on its inferior margin, which has received the name of the antrum. The relations of the pylorus, in the position it normally occupies, are as follow :—Anteriorly, the abdominal wall; posteriorly, the pancreas; above, the liver; and below, the inflection inwards of the peritonæum to form the sac of the omentum. The œsophageal orifice of the stomach, is situated at the left extremity of the lesser curvature, on a plane superior and posterior to its pyloric; it has the left lobe of the liver in front of it, and partially embracing it, while the lobulus Spigelii is thrust in behind it.

Exclusive of the pressure of the surrounding parts and its vessels, which in some degree serve as vital ligaments, the stomach is maintained in position by its direct connexion with the œsophagus and duodenum; by the lesser omentum, which binds it to the liver; by the splenic, which unites it to the spleen; and by the great omentum, which connects it to the transverse colon; a distinct process of peritonæum is also reflected on it from the diaphragm (diaphragmatic fold) around the œsophagus, which serves to attach it directly to that respiratory muscle.

Structure.—The stomach has four coats,— serous, muscular, fibrous, and mucous. Of these, the first or SEROUS may be considered to be almost perfect; it is derived from the gastro-hepatic omentum, which splits to inclose it, and is closely adherent to its central portions on both surfaces, but loosely attached towards its margins, where a triangular interval is always left, about an inch in extent, to allow the stomach to expand under the effect of food, as well as to accommodate the vessels which are destined for its supply.

Muscular Coat.—Between this and the serous coat, a thin layer of areolar tissue is observed, but so irregular in its character that it scarcely deserves the name of a separate tunic. The muscular fibres are arranged in three sets,—longitudinal, circular, and oblique; of these, the first or longitudinal are directly continuous with those of the œsophagus, as they pass vertically downwards from that tube, and expand over the anterior and posterior surfaces of the stomach; but still they are loose and scattered, except at its upper margin, where they form a well-marked band, extending as far as the pylorus, into which the deeper fibres sink and there terminate, while the more superficial can be traced for some distance on the duodenum.

The Circular Fibres, form a series of distinct rings extending from the œsophagus to the pylorus. Near the gullet, and over the great extremity of the stomach, they are few in number, with broad intervals existing between them; but as we approach the pyloric end, they become better marked and more closely packed together, particularly at the junction of the right with the middle third, where they form a remarkable constriction, described by Sir Everard Home, and said to be the analogue of the bilocular stomach in the horse. They occasionally cross each other very obliquely, and do not always constitute complete circles; while at the pylorus they are very dense and strong, and form the constriction, which is there visible.

Oblique Fibres, are found only on the great extremity; they cross each other very obliquely, and may be traced from the œsophageal orifice to the lower part of the great *cul de sac*.

The Muscular Fibres of the stomach are pale, and sometimes remarkably indistinct. They belong to the involuntary class, but a few striated are always visible amongst them.

Fibrous Coat.—The existence of this tunic was first pointed out by Bichat. It may be exposed by dissecting off the muscular fibres, when it will be observed, presenting a white glistening appearance, sufficiently strong to preserve the shape and general appearance of the organ, which may be proved by the following simple experiment: when the outer coats are removed as far as the fibrous layer, and a small perforation made in the latter, on forcibly inflating the stomach, the mucous membrane will be found to protrude; and again, if the organ is inverted, and the mucous membrane dissected off, a similar result will follow with respect to the muscular layers, when inflation has been carried to a sufficient extent. The fibrous coat is reticular in its arrangement, and is closely adherent to the muscular.

Mucous Coat.—This can only be examined properly in a recent stomach, which should be everted, and the mucus washed off by a gentle stream of water. It is smooth and soft to the touch, of a pale pink colour, not of an uniform hue, but alternately represent-

ing lighter and darker shades, marked by a series of sinuous folds, generally longitudinal, but sometimes intersected by others, taking an oblique direction (rugæ), with intervening furrows,—those folds being more numerous and better developed near the pyloric orifice and its inferior border, for the purpose of permitting rapid distention, in which state they become nearly obliterated. At the œsophageal orifice it forms small, loose, pendulous processes, divergent like the rays of a star, which may likewise be effaced by the dilatation of that tube, and these are said to be typical of the valve found at this position in the horse. At the pyloric opening, it is loosely folded around the muscular ring, presenting a rounded constricted orifice, partially impeding the transit of the chyme from the stomach into the duodenum, and equally preventing its regurgitation from the latter into the former. It is very slightly connected to the subjacent fibrous tunic by fine areolar tissue, and is much denser and stronger towards its œsophageal than towards its pyloric extremity, while it is covered in its entire extent by a thin layer of columnar epithelium. But although the surface, on a cursory examination, appears to be smooth and uniform, it is not really so, as it is studded with numerous elevations, each presenting a small pit or depression, in the bottom of which are apparent the orifices of several small tubes, which, if traced by a vertical section, are found to terminate by a cœcal extremity in the submucous tissue; these are the follicles for the secretion of the gastric fluid, so essential to the process of chymification, the principal constituents of which are—muriatic, acetic, and lactic acid, but the first preponderates greatly in quantity; and of muriates of lime, potash, and soda, with a peculiar product termed pepsin, and a large proportion of water. The walls of the alveoli, or depressions, in which those tubes are placed, are thickly studded with follicles similar to those of Lieberkuhn in the small intestines, which dip into the mucous membrane nearly as far as the submucous tissue; they are lined internally, by an aggregation of conoidal epithelial cells, so closely packed together, as only to leave at their free extremity a very minute orifice for the escape of the mucous secretion; while the intervals between the several follicles, are filled up by a vascular network, which extends to the surface of the stomach, but is still covered by a layer of epithelium.

With respect to the action of the several planes of muscular fibre of the stomach, the particular function of each has not as yet been accurately determined. The researches of Dr. Beaumont have, however, established the fact, that the food during chymification performs a rotatory movement from left to right along the great curvature of the stomach, and again from right to left along its lesser. It may be therefore assumed, that the longitudinal fibres of its upper and lower

borders, by being alternately in a state of relaxation and contraction, would have a tendency to impart this motion to the alimentary mass; while the oblique, situated at its great extremity, would as naturally, by their tension, expel it from the large *cul de sac* of the organ; the function of the circular fibres, is evidently, to propel such portions as are properly chymified, through the pyloric orifice into the duodenum.

The arteries which supply the stomach are—the coronary from the cœliac axis, and the superior pyloric from the hepatic, inosculating between the layers of the lesser omentum on its concave border; and the two epiploic, the one a branch of the gastro-duodenalis, the other of the splenic, anastomosing on its inferior edge between the folds of the great omentum, with some large twigs from the latter,—the vasa brevia being confined especially to its great extremity. It receives its nervous supply both from the cerebro-spinal, and ganglionic system; the vagi, and numerous branches from the solar plexus, being freely distributed to it.

Before concluding our remarks on the stomach, it may be necessary to observe, that we are by no means to judge of the distance between the œsophageal and pyloric orifices, by the general transverse breadth of the organ, for the two openings are in fact, comparatively close to each other, merely separated by the short concave border, which very nearly approximates in length in all individuals. The œsophageal opening is directed nearly vertically upwards, and lies on a plane superior and posterior to the pyloric, which looks upwards, backwards, and towards the right side.

The stomach is merely a dilated appendage of the alimentary canal, and as such is comparatively small in the fœtus. At that period of life, it is also remarkable for its vertical direction,—a position in a great measure depending on the very large size of the left lobe of the liver, as well as on the nature of the food which it employs for nutrition not demanding the same elaborate process of chymification, as the more solid constituents which form the basis of support in the adult; and hence the transverse width is not required to retain it for a certain length of time within its cavity, nor is extreme size essential for the same reason. The stomach of the female, is smaller than that of the male, and more liable to abnormal displacement, owing to causes connected with dress, habits, &c.

Duodenum, is a direct continuation of the stomach, commencing at the pylorus, opposite the horizontal fissure of the liver, from which it takes a curved direction, to terminate at the second lumbar vertebra by uniting with the jejunum, the point of junction between them being marked out by the attachment of the mesentery to the latter, and by the passage of the superior mesenteric artery, which crosses

between them nearly at a right angle. The name—duodenum—has been derived from its supposed length, which is said to be equal to twelve fingers, laid side by side, or nine inches. Curved in its general outline, with the convexity directed towards the right side, it forms about three-fourths of an irregular circle, and has been divided into three portions—two transverse, a superior, and an inferior; connected by the third which is vertical. Of these, the superior transverse, is the shortest, being not more than two inches in length; it passes obliquely from the pylorus, upwards, backwards, and towards the right side, terminating at the liver, which it slightly grooves a little external to the gall bladder. At this point, the vertical commences its course, running almost perpendicularly downwards, until it arrives opposite the third lumbar vertebra; its length is scarcely three inches. The inferior transverse, extends from the termination of the vertical, upwards, forwards, and towards the left side, crossing the spinal column opposite the second lumbar, where the jejunum commences; it is about four inches in extent. If we now proceed to examine the relations of each separately, we will find them to be very complicated. The superior transverse portion, rests upon the right crus of the diaphragm, and psoas muscle, the portal and caval veins, gastro-duodenalis and hepatic arteries, ductus communis choledochus, and sympathetic nerve; above, it has the right lobe of the liver, foramen of Winslow, and gall bladder, with the exudation from which it is always partially stained; in front, the hepatic flexure of colon and gastro-colic omentum; and below, the upper edge of the pancreas, and gastro-duodenal artery dividing into gastro-epiploica dextra, and pancreatico-duodenalis. The vertical portion rests in its descent on the kidney, and on the vena cava, which is rather internal to it; in front of it, is the ascending portion of the colon, but lying rather external to it; internal to it, is the pancreas, but separated from it by its own, as well as the common bile duct, and pancreatico-duodenalis artery; and external to it, the abdominal wall. Inferior transverse, has behind it, the quadratus lumborum, psoas, and right crus of the diaphragm, ureter, vena cava, sympathetic nerve, and aorta, from which it is separated by the left renal vein; anterior to it, is the splitting of the transverse mesocolon, stomach, and superior mesenteric artery; above it, the pancreas; and below it, the attachment of the root of the mesentery.

From the tortuosity of this portion of the gut, it necessarily follows that it must partially occupy several regions of the abdominal cavity, and we accordingly find it in the epigastric, right hypochondriac, lumbar, and umbilical. The degree of motion which it enjoys in each of these is very unequal, but to this we shall again advert.

The remainder of the small intestine has been known by the names of jejunum, and ileum,—an arbitrary distinction at the best, as no real line of demarcation exists between them, it being absolutely impossible to determine the termination of the one, or the commencement of the other. To follow however, the received rule, we may state that the upper two-fifths has been called the jejunum, from the empty condition in which it is usually found; while the remaining portion has been termed the ileum, from the numerous well-marked convolutions which it forms. As the whole however, gradually diminishes in size from its commencement to near its termination, its extremes, of course, must naturally present very obvious differences; but about three inches before it reaches the right iliac fossa, where it joins the cœcum, it again expands, and has a flattened appearance. The arrangement, which nature has employed in order to accommodate the great extent of the intestinal tube, to the circumscribed cavity in which it is contained, is strikingly beautiful. Disposed in coils, each constituting nearly a complete circle, the convexity of which is directed downwards and forwards, it is embraced by the serous membrane, which springing from the root of the mesentery, passes downwards in front of each, to return again behind it, to be attached to the same point; and thus a series of folds is formed, lying upon and beside each other, but still floating so loosely, and so freely lubricated by the exudation of their investing membrane, as not to interfere, in the slightest degree, with the motions so requisite for the functions which they are destined to perform. Their convolutions may be said to occupy, more or less partially, all the regions of the abdomen, with the exception of the three superior; but they are found in greater abundance, on the left than on the right side, owing to the position of the liver, whilst they extend likewise into the pelvic cavity.

The small intestine, consisting of the three parts enumerated, possesses, like the stomach, four distinct coats,—a serous, muscular, fibrous and mucous.

Serous, is disposed in a very peculiar manner on the duodenum, not investing all its several portions, in the same degree. Like the stomach, with which it is continuous, the superior transverse portion receives its envelope from the lesser omentum, which covers it completely, except at its superior and inferior margins, where intervals are left, in same manner as on that viscus. This arrangement naturally bestows on this particular part, a great amount of mobility, a characteristic which is deficient in the other two portions, which are fixed, more or less firmly in their position, the inferior by the splitting of the transverse mesocolon, and the vertical by its ascending layer. The two latter are, therefore, only covered on their an-

terior surface, and partially on their sides. The remainder of the small intestine, the jejunum and ileum, receives however, a more complete investment from the peritonæum, as with the exception of the slight interval on its superior posterior border opposite the attachment of the mesentery left patulous, for the entrance of the arteries, and emergence of the lacteals, the covering is perfect, and also very adherent.

MUSCULAR FIBRES consist of two distinct layers,—a longitudinal and a circular; the former, being the most superficial, and prolonged immediately from the stomach to the duodenum, and so in succession to the jejunum and ileum. In the first, they are pale, indistinct, and widely scattered; but in the two remaining portions, they become much better marked, and more closely approximated to each other. They do not however, consist of continuous fibres, running without interruption from one extremity to the other, but of several fragments of varying length, which appear to overlap and indigitate with each other. The circular fibres, which lie immediately beneath the longitudinal, are of a denser and stronger character; they appear to form perfect rings around the gut, not always parallel, but occasionally crossing each other at a very oblique angle, and their general appearance is strikingly uniform in the whole course of the small intestine.

FIBROUS COAT, is precisely similar to the same structure in the stomach, being pale and thin, but remarkably strong.

MUCOUS MEMBRANE.—The pendulous ring which this forms at the pylorus has been already described, and from this point it forms a complete lining for the small intestine, as far as its junction with the cœcum. In order to observe the various modifications which it exhibits in its lengthened course, it will be necessary to divide longitudinal portions of the duodenum, jejunum, and ileum, and examine them under water, when several of its peculiarities, which would not otherwise be visible, will at once become manifest.

The mucous membrane of the superior transverse portion of the duodenum, is generally uniform in its character, presenting a smooth velvet-like appearance, of a pale pinkish hue; but as we pass on to its vertical, and inferior transverse divisions, a gradual change ensues, both in its colour and general surface, the biliary secretion imparting to it a yellowish-brown shade, while it becomes elevated into numerous ridges, taking a transverse direction, called valvulæ conniventes, separated from each other by a series of corresponding furrows, or depressions. Those mucous folds are most evident in the lower parts, more especially in the neighbourhood of the opening of the ductus communis choledochus, the aperture for which is visible a little above the inferior angle, on the posterior internal sur-

face of the gut, marked out by a papilla which becomes very apparent under water. The valvulæ conniventes, always most prominent on the anterior wall of the gut, rarely form perfect circles, but more generally large segments, embracing about three-fourths of the cylinder, with their extremities bifurcating, and either indigitating with each other, or becoming insensibly lost on the adjacent surfaces. Nor are they peculiar to the duodenum only, for they are found also in the jejunum, and ileum, although they gradually diminish both in size and number as we descend, forming little more than linear elevations in the last named portion. On dissection, they are seen to be folds of fine areolar tissue, supported on the fibrous framework of the gut, and covered by the mucous membrane. According to the opinion of some anatomists, they are said to be of use in favouring the rapid distention of the gut, but this theory cannot be correct, as the utmost dilatation which can be employed without rupturing the intestine, will never perfectly obliterate them; besides, their direction, which is transverse, is a strong argument against such a supposition. It would therefore, appear more probable that their object is to retard the food in its passage, and by delaying its too rapid transit, to subject it to the prolonged action of the absorbents, a more extended surface for which, is admirably obtained by this beautiful arrangement. The mucous membrane in the upper part of the small intestine, is much thicker and more vascular, than in its lower; but in its whole course, it is only loosely connected to the subjacent fibrous tunic, by fine areolar tissue.

Glands.—In the superior transverse, as well as in the upper part of the vertical portion of the duodenum, a series of granular bodies may be observed, about the size of a small grain of shot, flattened, of a pinkish grey colour, and situated in the submucous tissue, being very numerous at first, and closely impacted together, but becoming more scattered as they descend. They were first described by Brunner, and have since been called after the name of that anatomist (Glandulæ Brunneri). They appear to be identical in structure with the salivary glands, and pour their secretion on the mucous membrane, each by a single duct; but with respect to the nature of the fluid which they elaborate, or its uses in the animal œconomy, nothing is as yet distinctly known.

Solitary Glands, are found not only in the small, but likewise in the large intestine, and they appear to increase in number, according as they descend through the alimentary tube. They may be regarded as closed saccules, being about the size of a millet seed flattened out, oval in shape, white in colour; and discharging, when laid open, a kind of fibrinous fluid, intermixed with granular cells. It is still a disputed point, whether they have any distinct orifice

opening on the gut; but the highest authorities assert that they have not, and entertain the opinion, that the foramina or depressions visible occasionally on their surfaces, and around their margins (crypts of Lieberkuhn), are cœcal, and do not communicate with the cavity of the vesicle. It is therefore supposed, that the fluid, having accumulated to a certain amount, presses on the anterior wall until a fissure results, through which it escapes, when the breach is again repaired for the production of a fresh secretion, the nature of which is not clearly understood, but is conceived to be an elimination from the blood of something noxious and deleterious, which nature is anxious to remove from the system by this process (Carpenter).

Aggregate Glands, also, known as the glands of Peyer, who was the first anatomist who described them accurately, are found in masses of variable size, and of an oval shape, on the anterior or convex wall of the intestine. They are seldom, if ever, to be observed in the duodenum; while they are thinly scattered in the jejunum; and are numerous in the ileum, the last patch being found on the ileo-cœcal valve. They are evidently nothing more, than an aggregation of the solitary glands, but much smaller in size; each patch being surrounded by its zone of cœcal depressions, and occasionally presenting one also in the centre. It may therefore, be safely argued that their function is similar to that of the solitary, whatever that may be; and this appears to derive confirmation, from the analogous nature of the contained fluid. In typhoid fevers, and phthisis, these glands become the receptacles of a specific deposit, which produces their subsequent ulceration; whilst in remittent fevers, the glands of Brunner become much more apparent, in consequence of their increase in size.

Follicles of Lieberkuhn, are found throughout the whole extent of the intestinal canal, and consist of a series of small tubules; their cœcal extremity extending as far as the submucous tissue, while their free is marked by a small aperture opening on the mucous surface. They are very closely packed together, and are covered by conoidal epithelium, which extends also into the cavity of the tubule, from which is poured out the succus intestinalis, for the purpose of preserving the proper moisture of the gut; while the *crypts* of Lieberkuhn, depressions formed by the involution of the mucous membrane, accomplish apparently a similar object. In periods of inflammation, the follicles become very manifest, as they are then filled by a quantity of white tenacious secretion, which renders them much more easy to be distinguished.

Villi, are minute processes, distributed throughout the entire of the alimentary tract; but are much more numerous in the small, than in the large intestines, where they are very few in number; it has

been stated that they are altogether absent in the superior transverse, and upper part of the vertical portion of the duodenum (Carpenter). They are foliaceous in shape, consisting of an involution of mucous membrane, freely supplied by a capillary plexus of both arteries, and veins; but they appear to be totally deficient in nerves, and are, generally speaking, about one-fourth of a line in length. A vertical section exposes a single duct, or sometimes two or three, which anastomose together; this becomes dilated as it approaches the base of the villus; but on the free surface of the gut, no orifice is visible. They were formerly supposed to be covered in, by a close network (Meckel), but according to more recent researches, they are found to be clothed with a series of cells of the conoidal class, which are endowed with the property of selecting and absorbing solely the chyliferous products, and which, when fully distended with this fluid, burst discharging their contents into the ducts within the villus, leaving behind their nuclei, for the regeneration of another series of cells, which are again destined to perform the same office (Goodsir). The nutritive portion of the food, having by this means, entered within the cavity of the villus, is transferred from it to the *lacteals*, a class of vessels remarkable for the thinness and transparency of their coats, which run between the layers of the mesentery, traversing in their course the numerous glands which are found in this position; they anastomose frequently, and gradually diminish in number, until at length reduced to five or six, they pour their contents into the receptaculum chyli, or dilated extremity of the thoracic duct, which is situated opposite the third lumbar vertebra on the front of the spine, immediately behind the abdominal aorta, from which the chyle is ultimately carried into the general venous system.

The absorbent surface occupied by the villi, is necessarily much increased by the mucous folds, or valvulæ conniventes, which have been already described, as occupying the superior part of the small intestine principally; and we accordingly find that they are more numerous where these processes are best developed, as in the lower portion of the duodenum, and entire of the jejunum; but where these begin to diminish in number, and become less marked, so also do the villi decrease in the same ratio; as, towards the termination of the ileum, where they are thinly scattered over the surface of the gut. We have already alluded to the manner in which the small intestine tapers gradually, from the pylorus, to within about two inches of its termination, where it again slightly expands, till it reaches the cæcum, and unites with that portion of the gut, at an acute angle. The manner in which this union takes place is peculiar, and can only properly be understood by examining the dry preparation. On the

posterior and internal part of the cœcum, just at its junction with the colon, is an elliptical aperture, more concave on its inferior than on its superior border; long from behind, downwards, and forwards, the two lips which compose it, meeting anteriorly and posteriorly, at a very acute angle. The ileum, on reaching this aperture, is united to it by the peritonæum, which is tensely reflected from one to the other; and also by its longitudinal muscular fibres, which are arranged in a similar manner; but its circular fibres, basement membrane, and mucous lining, appear to be thrust into the aperture, to form two remarkable valves, the ileo-colic, and ileo-cœcal, which jut prominently out, within the cavity of the cœcum. That this is really the mode of their formation, may be proved, by the simple experiment of dissecting away the connecting media,—the serous membrane, and longitudinal fibres,—when, by pulling on the ileum, the valves will become effaced. In their natural condition, these valves are of a crescentic shape, being attached by their convex borders to the edge of the cœcal aperture, while their free borders are closely approximated to each other, admitting however, of easy divarication, so as to allow an uninterrupted passage, for the intestinal contents to pass between them. The position of these valves, is not exactly similar; as the ileo-colic, stands out at nearly a right angle, from the wall of the gut (the horizontal); while the ileo-cœcal is more oblique, bending upwards, and towards the right side (the vertical); the free margin of the former, being slightly concave; while that of the latter, is a little convex. From the angles of the orifice, where they unite, strong bands of fibrous tissue (retinacula) pass off, covered of course, by the mucous membrane and are gradually lost on the circumference of the cœcum; but they do not appear to unite, the posterior being evidently the longest and densest. The use of these valves is to prevent regurgitation, from the large into the small intestine, but they only do so partially, as the gaseous and liquid constituents can undoubtedly return. It may be scarcely necessary to add, that the closure of the valves depends upon the distention of the colon and cœcum, which by separating the angles, has a tendency to approximate their edges.

Before leaving this subject, it may be necessary to sum up briefly the more striking differences that are found to exist in the character of the jejunum, and ileum. Thus, the first is much larger in calibre, has thicker walls, more valvulæ conniventes, and solitary glands, and is also more vascular; while the ileum possesses more aggregate glands, and its appearance is always of a darker colour, from the gravitation of venous blood.

Large Intestine, consists of the cœcum, colon, sigmoid flexure, and the rectum; those several portions of the gut from the pecu-

liar direction which they pursue, being found in the following regions:—Commencing in the right iliac fossa by a dilated pouch, the *cæcum*, it passes upwards through the right lumbar region, till it reaches the liver (*ascending colon*); from this point it stretches across the umbilical region, forming a variable curve, the convexity of which is directed downwards and forwards, as far as the spleen (*transverse colon*); from this it again descends through the left lumbar, as far as the left iliac fossa (*descending colon*), where it becomes very tortuous, until it reaches the sacro-iliac synchondrosis (*sigmoid flexure*); in the remainder of its course it is found in the pelvis, and known by the name of *rectum*. It may be here generally stated, that the large intestine gradually diminishes in size from the cœcum to the sigmoid flexure, but again gradually increases in circumference from that flexure to the lower part of the rectum; the whole somewhat resembling two hollow cones, with the apices united in the left iliac region.

Cœcum, or Caput Coli, is of a triangular shape, with the base above, continuous with the ascending colon, which it joins at an obtuse angle, salient towards the right side; and the apex below, presenting not a pointed, but a rounded extremity. It is of variable length, but always limited by a section carried horizontally across, immediately above the part perforated by the termination of the ileum; and as it lies in position, it occupies the right iliac fossa, resting upon the iliac fascia, and connected to it by a quantity of loose areolar tissue; in front it corresponds to the abdominal wall, from which it is usually separated by some coils of the small intestines; externally, it is in relation with the wall of the iliac fossa, internally with the ileum; and inferiorly, with the vermiform appendix.

Processus Vermiformis.—A narrow, wormlike appendage, springing from the posterior and internal part of the cœcum; is very irregular in length, ranging from one to six inches; and is equally so in its position, being sometimes found in the iliac fossa, sometimes in the pelvic cavity, and sometimes coiled up behind the cœcum itself. In calibre, it is about as large as a goose-quill; and at its point of junction with the gut internally, a loose valve is thrown across, but it does not appear to be sufficient to prevent the entrance of fæcal matter, which is often found within it, or the ingress of certain foreign bodies, the dangerous effects of which are now unfortunately too well understood. The peritonæum, which is inflected around it, is sometimes extremely long and falciform, conferring on it a degree of mobility, which is occasionally very extensive; but with respect to its use in the human subject, nothing definite is known.

Ascending Colon, reaches from the cœcum as far as the inferior

surface of the liver, which it slightly grooves, and is comparatively straight. In its course upwards, it rests on the quadratus lumborum and right kidney, but is separated from them by a quantity of loose areolar tissue ; anteriorly and externally, it corresponds to the abdominal parietes, from which it is generally separated by a few folds of the small intestine; also directly in front, but above, to the right lobe of the liver; while internal, but on a plane posterior to it, is the psoas muscle, and the vertical portion of the duodenum.

Transverse Colon, extends from the liver, where it passes from the ascending, nearly at a right angle, as far as the spleen ; there uniting with the descending, at an acute angle. It is not exactly horizontal, but forms a curve, the convexity of which is directed downwards and forwards, and it is found in both hypochondriac regions, as well as partially in the epigastric, and the umbilical. Its relations are :—in front, the abdominal parietes ; behind, the root of the mesentery, and transverse mesocolon ; above, the liver, gall-bladder, inferior border of stomach, and spleen ; and below, the small intestines.

Descending Colon, stretches from the spleen, where it passes from the transverse at an acute angle, as far down as the left iliac fossa, occupying that, as well as the left hypochondriac, and lumbar regions. It differs from the ascending, in being more deeply situated ; and presents a slight concavity, which is directed forwards. In its course downwards, it is supported by the left kidney, and quadratus lumborum ; and has in front of it, the small intestines, which are also folded in external to it; while on its inside, it is in relation with the psoas.

Sigmoid Flexure, is that portion of the gut lying between the descending colon above, and the rectum below ; but it is difficult to define its limit in either direction, as it is very irregular in its length ; it may vary from six inches, to three feet in extent; but it is always convoluted, and imparts to the touch a denser and thicker feel, than the rest of the large intestine, while the serous membrane is so loosely reflected around it, as to confer on it, an amount of mobility, nearly equal to that of the ileum, and jejunum. It corresponds, by its deep surface, to the iliac fossa; and in front, to the abdominal parietes; while in every other direction, it is enveloped by the convolutions of the small intestines.

Rectum.—This portion of the gut, so called from its direction in early life, is very incorrectly named in the adult; as from its designation it might be presumed to be perfectly straight, which is far from being the case. It commences at the left sacro-iliac synchondrosis, a point which is rather arbitrary, and takes a curved and tortuous direction downwards, to terminate at the anus. It has generally been divided into three parts : the first, extending from its origin to

the third piece of the sacrum, and passing obliquely downwards, backwards, and towards the right side ; the second, from the last named point to the tip of the coccyx, its course being downwards, forwards, and slightly to the left side ; and the third, which is the shortest, from the tip of the coccyx to the verge of the anus, its direction being downwards and backwards. There is a marked dissimilarity in the calibre of these three portions ; the first being constricted, particularly at its commencement ; the second gradually increasing in size, and forming at its junction with the third a large dilatation ; while the third becomes gradually constricted, as it approaches the anus, where it is embraced by the sphincters.

Relations.—Posteriorly, it corresponds to the ilio-sacral symphysis, pyriformis muscle, sacral plexus, middle sacral artery, sympathetic ganglia, coccyx, ano-coccygeal ligament, and posterior fibres of levatores ani ; anteriorly, to the *cul de sac* of peritonæum, which is usually filled with the convolutions of the small intestines, base of the bladder, vesiculæ seminales, and vasa deferentia, prostate gland, which is intimately connected to it, and recto-bulbar space ; laterally to the ureters, a mass of loose areolar tissue, and insertion of the levatores ani, which separate it from the ischio-rectal fossæ, at each side.

The large intestine, like the small, has four coats,—a serous, muscular, fibrous, and mucous; these, we will now proceed to examine, in succession.

Serous Coat, is very variously arranged, on the several portions of the large intestine; and may also differ materially, in the mode in which it is disposed, in different individuals. Generally speaking, it is so placed over the cœcum, ascending and descending colons, as to cover them anteriorly and laterally, while it is deficient posteriorly, fine, loose, areolar tissue being sustituted for it. Exceptions, however, occur to this rule, particularly in the case of the cœcum, which may occasionally be connected to the iliac fossa by a species of mesentery, of variable extent, bestowing on it a degree of mobility, which is not generally the characteristic of this portion of the gut. The transverse colon, on the contrary, may be said to be almost completely surrounded by the peritonæal investment, which is derived from the reflected layers of the great omentum, splitting to receive it, and hence the facility with which it is enabled to change its position. The fold which connects the sigmoid flexure to the left iliac fossa, is generally very loose and long, and consequently embraces it almost completely. The rectum receives a perfect tube from it, only on its superior third; on its middle, only a partial covering in front, and laterally ; while on its inferior, it is altogether deficient. The serous membrane likewise contains within its layers, and binds to the large intestines, a series of fatty processes (appendices epiploicæ), which are generally

found on its anterior, and internal walls; those processes are of variable size, being sometimes exceedingly small, or again so large as nearly to form a covering for the entire calibre of the gut. Their precise use is not however known, although they have been usually described as reservoirs of nutrition, a theory which certainly is not borne out by fact, for we have repeatedly observed them of a more than ordinary size, in cases where emaciation had proceeded to very great extent. In the infant, they are always absent.

Muscular Coat, consists of two planes, a longitudinal, and a circular; the former can be traced from the apex of the vermiform appendix to its base, where the fibres are very numerous; as they pass up on the cœcum, they converge towards three distinct points, so as to form three bands, extending along the gut, generally as far as the upper third of the descending colon, but occasionally to the commencement of the sigmoid flexure, where they are reduced in number to two, those on the posterior surface gradually converging, and at last uniting with each other; on the inferior part of the sigmoid flexure, they are scattered to a greater or lesser degree, and for the whole extent of the rectum, surround it completely, appearing at last to be blended with the fibres of the levatores ani. Of the three bands which are found on the ascending colon, one is anterior, strong, dense, and of a glistening whiteness; one posterior, and external; and one posterior, and internal; the two latter, being weaker, and badly marked. On the transverse colon, the position of these bands becomes changed, that which was anterior becomes inferior, that which was internal, superior, and that which was external, anterior: while on the descending colon, they again resume the arrangement which they bore on the ascending, this transposition, in fact depending on the torsion of the tube, and not on any positive alteration in the direction of the bands. The remarkable sacculated appearance, which this portion of the intestinal canal presents, is attributable to those longitudinal fibres, which being at least one-third shorter than the gut itself, produce that puckered condition of the tube, to effect a correspondence in length, between the two; an arrangement, admirably calculated to allow increase of surface, without additional elongation. We have already stated, that at variable points on the descending colon, the two posterior bands unite and form one, a condition which continues nearly as far as the termination of the sigmoid flexure, where they become scattered, and of a redder colour, surrounding the rectum as distinct fibres, being very similar in their character, but not quite so strong as those of the œsophagus, a few of the striated, or voluntary class, being often found among them.

The Circular Fibres, exposed by cautiously dissecting off the longitudinal, form as on the small intestine, a series of rings, embracing

the gut as far as the sigmoid flexure, where they become much thicker and more closely united together. Their density continues to increase on the rectum, till we approach the verge of the anus, around which they constitute a dense fasciculus of about an inch in depth (internal sphincter), which completely encircles it. The colour is likewise more vivid, and the voluntary, and involuntary, class of fibres are completely intermingled in this last situation.

Fibrous Coat, is of the same character, as that already described on the small intestine.

Mucous Coat, is much paler than that of the small intestine, and more loosely attached to the fibrous tissue beneath. Properly speaking, it has no valves, if we except the ilio-colic and ilio-cœcal already described. Its folds are few, and always indistinct and imperfect; for the large saccules, which are visible on laying open the gut, are equally formed by the fibrous and muscular coats. The existence of the villi has also been denied, but there are thickly studded follicles, nearly analogous to those of the stomach. Solitary glands, or structures very similar to them in appearance, may be also observed; and a vertical section, shows that they are of a flask-like shape, with the broad extremity resting on the basement membrane, and the narrower portion corresponding to the free surface; they appear, however, to be open-mouthed, without the covering which they have in the small intestines, and are thickly covered with epithelium (columnar), which sinks into the cavity of the small depressions, lining them throughout; their use is evidently, for the purpose of insuring the mucous secretion, with which this portion of the gut is so abundantly supplied.

In the Rectum, the mucous membrane is particularly thick and smooth, and but loosely attached to the subjacent tissues; it is also very vascular, deriving its supply of blood, from several and different sources. Some remarkable folds are also visible on it, first accurately described by Dr. Houston—generally three, but sometimes four in number, and are arranged in the following manner:—The first is on the right side, just at its commencement, opposite the right sacro-iliac synchondrosis; the second, on the left, opposite the third bone of the sacrum; the third, anteriorly, corresponding to the base of the bladder; while the fourth, when it does exist, is found posteriorly, between the third and the verge of the anus. In order to obtain a good view of those folds, the rectum should be cleared out, and while still *in situ*, filled with spirits of wine, which will have the effect of hardening its tissues, and thus affording an opportunity of making a longitudinal section of the gut, by which means those mucous elevations will be rendered apparent. According to the views of Dr. Houston, those folds may be considered as a species of

shelves, which, by affording support to the fæcal matter in the intestine, may relieve the sphincter of a considerable part of the superincumbent weight; they may likewise perhaps, be of use in allowing the ascent and descent of the gut, in accordance with the contraction and relaxation of the levatores ani. The lateral dilatation of the rectum, has also been provided for, by a series of vertical folds, not always very distinct, extending from its commencement to its termination. The mucous membrane terminates two or three lines within the anal orifice, by becoming continuous with the skin, their point of union being indicated by a faint wavy line, which may be easily distinguished by dilating the part, so as to efface the radiating integumentary folds, which encircle the outlet. In this position, it is highly vascular; sometimes thrown into plicæ, studded with crypts or glands, and supported by a dense layer of erectile tissue; while the adjoining integument, in the male subject, is implanted with some scattered hairs, but this peculiarity is rarely observed in the female.

The arterial and nervous organization of the stomach having already been briefly alluded to, we will now proceed to state the sources from which a similar supply is imparted to the small and large intestines, reserving, however, a more detailed explanation of their course and individual relations, till a future period. The duodenum, receives its greatest amount of blood from the pancreatico-duodenalis; the jejunum and ileum, from the numerous branches of the superior mesenteric, which with the inferior mesenteric, also supplies the large intestine down to the termination of the sigmoid flexure; while the rectum, is supplied by the superior hæmorrhoidal a branch of the inferior mesenteric, the middle hæmorrhoidal from the internal iliac, and an inferior hæmorrhoidal from the internal pudic. The *effête* blood is carried back by corresponding venous trunks, which ultimately unite to form the *porta*, the destination of which is the liver. The nervous supply is derived from the great solar plexus, an offset of the sympathetic, which sends its numerous filaments to the entire of the hollow tube, the rectum likewise receiving additional twigs from the sacral plexus.

Development.—The alimentary canal is developed from the umbilical vesicle or yelk sac, and is at first a continuous tube, narrow and nearly straight, closed at both extremities till about the end of the second month, when the mouth and anus are found to make their appearance. Shortly afterwards, a small dilatation marks out the position of the future stomach, and the tube gradually assumes those curvatures which are to continue as the permanent distinctive characters of the large and small intestine. Properly speaking, a cœcum can scarcely be said to exist in the fœtus, or in very early infancy;

but it appears to be formed by the weight of the fæcal matter lodged in this dependent portion of the gut. The appendix vermiformis, of variable length, but always persistent, remains to mark out the original point of communication between the alimentary canal and the umbilical vesicle, a fact that was formerly doubted, but is now placed beyond dispute, by the investigations of recent observers.

LIVER.

Having now concluded our remarks on the hollow viscera, we will next proceed to examine the solid, commencing with the liver, as being the most important in the animal œconomy. It is the largest of all the glandular bodies; remarkable not only for its size, but likewise for its firmness, peculiar construction, and mode of secretion. When normally situated, it occupies the right hypochondriac, and epigastric regions; but sometimes, it may extend into the left hypochondriac, or into the right lumbar, or umbilical; and in forced inspiration, there can be no doubt but it descends more or less into the two latter, under all circumstances. In its general outline, it resembles an oblique section of an ovoid figure cut longitudinally, being longer in its transverse than antero-posterior diameter—the former measuring from ten to twelve inches, the latter from six to eight; and it presents for description, a superior, and inferior surface; an anterior, and posterior margin; and a right, and left extremity. The superior surface, smooth and very convex, but more particularly so on its right side, presents a slight sulcus to the left of the median line, corresponding to the falciform ligament, and lies in contact with the diaphragm, to the concavity of which it is accurately adapted; while its inferior, concave but irregular, is marked by a deeper sulcus running from before backwards, containing the obliterated umbilical vein, and ductus venosus, and separating it into its right and left lobes; this sulcus, known as the horizontal, or longitudinal, or *umbilical fissure*, is sometimes bridged over by a thin layer of hepatic structure (pons hepatis), which partially obliterates it, leaving however, a notch still apparent at its anterior margin, which marks out its ordinary position. This surface corresponds to the gall-bladder, angle of duodenum, and colon, suprarenal capsule, and right kidney, gastro-hepatic omentum, with the parts between its layers, hepatic artery, which embraces its Spigelian lobe, to the foramen of Winslow, and anterior surface of stomach. The posterior margin, is exceedingly thick, and marked by two depressions, the larger lying between the left and right lobes, deep and broad, corresponding to the vertebral column, aorta, and crura of the diaphragm; while the smaller, more to the right side, is occupied by the ascending cava; the whole of this edge corresponds to the diaphragm. The anterior margin, extremely thin, presents also

two notches—one already alluded to, for the insertion of the ligamentum teres, and the other for the base of the gall-bladder; it is in relation with the cartilages of the ribs, in its quiescent state; but in motions of respiration, usually descends below them, for about half an inch. The right extremity, very thick, corresponds to the five or six lower ribs, and the indigitations of the transversalis with the diaphragm; while the left, thin and sharp, is in contact with the great extremity of the stomach, but sometimes extends so far to the left side, as to touch the spleen.

The liver is retained in position, by five ligaments, four of which are merely folds of the peritonæum, viz., the falciform, coronary, and two lateral, while the fifth is the obliterated remnant of the umbilical vein, known as the round Ligament, or Ligamentum Teres.

Ligamentum Teres, takes its origin from the fibrous tissue of the umbilical orifice, to which it is firmly adherent, and passing upwards, and to the right side, is inserted into the notch at the thin margin of the liver. Its use appears to be, not so much to suspend the liver, as to keep it closely fixed to the abdominal wall; and thus to relieve the stomach from that pressure, to which it would be otherwise necessarily subjected.

Falciform Ligament, a double fold of peritonæum, carried down from the abdominal wall to the upper surface of the liver, over which it is afterwards reflected; is triangular in shape, and accordingly presents two margins—an anterior superior, and a posterior inferior; with a base, and an apex. The anterior superior margin, is convex, and attached to the right side of the linea alba, and inferior surface of the diaphragm; while the posterior inferior, is concave, and corresponds to the upper surface of the liver, with the serous investiture of which it becomes blended. The base is free, looks downwards and backwards, and contains within its folds the umbilical vein; while the apex, pointing upwards and backwards, bifurcates into two processes to form the *Coronary* ligament.

Coronary, similar in figure to the flukes of an anchor, attached above to the diaphragm, and below to the liver, can be traced out on either side, to become continuous with the *Lateral* (or *Triangular*) ligaments.

The Lateral, are situated at the posterior edge of the liver; the left, lying immediately in front of the œsophagus, pneumogastric nerves, and superior coronary artery; while the right, occupies a position external to the groove for the vena cava. In addition to those ligaments, the vessels, and duct, with the pressure of the adjacent viscera, assist materially in keeping the liver *in situ*.

It is to be presumed that the student has already examined the arteries, great veins, and duct, in this region; and having done so, he

may now proceed to remove the liver, by dividing its connexions to the walls of the abdomen, as well as the vessels in relation with it, taking care however, to leave sufficient length of the vessels, to enable him to observe their ultimate course and destination. He may now also clean away the loose areolar tissue, and peritonæum from the fissures, and proceed to examine more accurately, and more in detail, the several peculiarities of this organ.

We have already stated that the liver on its upper surface is convex, and marked by a slight antero-posterior groove, corresponding to the falciform ligament, which divides it into its two lobes, the right being at least three or four times larger than the left, while its inferior, much more irregular, presents a deep antero-posterior sulcus, which, as has been previously stated, is sometimes converted into a complete canal by a process of the liver which is thrown across it, containing anteriorly the obliterated umbilical vein, and posteriorly the ductus venosus. Passing off at a right angle from this sulcus, horizontal, or longitudinal fissure, and extending for about an inch and a half on the right lobe, is another groove, broad and deep, limited externally by the groove for the gall-bladder, and situated a little behind the middle of the liver; this is the *transverse fissure*, which must be regarded as of great importance; for through it, the vessels, duct, and nerves, enter and emerge. At its right extremity, the sulcus for the gall-bladder commences; it passes downwards and forwards, generally as far as the free margin of the liver, and corresponds in shape to the figure of the contained viscus. On the posterior thick margin, is observed the fissure for the vena cava ascendens; it is placed on the inner side of the right lobe, infringing partially on its inferior surface,—it, as well as that for the gall-bladder, being occasionally converted into a complete canal, by a portion of the liver being continued over them. Thus we may observe that the liver presents, on its lower aspect, five fissures, which may be recapitulated as that for the gall-bladder, that for the umbilical vein, that for the ductus venosus, that for the vena cava; and the transverse, for the hepatic artery, duct, nervous plexus, portal vein, absorbents, and capsule of Glisson. With respect to the depressions, they are found to be exactly similar in number, and may be enumerated as the superficial excavation, on the under surface of the left lobe, corresponding to the stomach; the deep notch posteriorly, embracing the vertebral column, and crura of the diaphragm; the depression on the posterior and external part of the right lobe, for the kidney, and suprarenal capsules; and the two in front of the transverse fissure, always superficial; the most anterior and external, for the angle of the colon; and the posterior and internal, for the sharp curve of the duodenum.

The liver has been primarily divided into two great lobes, the right, and left; this division being formed on its upper surface by the falciform ligament, and on its under by the longitudinal fissure; but the former, or right lobe, has been again subdivided into three others,—the lobulus quadratus, lobulus Spigelii, and lobulus caudatus,—while some anatomists admit even a fourth,—the lobulus dexter. The positive distinctions, however, between these several lobules are not always uniformly marked, and in many instances they must be considered as purely arbitrary. The RIGHT LOBE may be said to form the greatest bulk of the entire organ, and in its superficial outline is quadrilateral, its left margin being rather shorter than the right, the latter being also much thicker in vertical depth. The LEFT LOBE, on the contrary, is comparatively thin in its whole extent, and very irregular in shape and size, being sometimes oval, sometimes triangular, and sometimes marked with a narrow tongue, thin and overlapping the spleen; generally speaking, it is one-third or one-fourth the size of the right; but we have had opportunities of witnessing instances where it had no existence at all, and where the umbilical vein ran along the left edge of the one solitary lobe.

LOBULUS QUADRATUS.—Quadrilateral in shape, with its greatest length antero-posteriorly, is bounded in front, by the free anterior edge of the liver; posteriorly, by the transverse fissure, and the parts entering into it; to the left side, by the horizontal fissure, and the umbilical vein; and to the right, by the gall-bladder, and the sulcus in which it is contained. It is sometimes, only a mere oblong slip.

LOBULUS SPIGELII, so called from the anatomist who first described it, is a tongue-shaped elevation, dependent from the under surface, and posterior part of the liver; bounded in front, by the transverse fissure; behind, by the thick edge; to the right side, by the fissure for the vena cava; and to the left, by the ductus venosus. But when in position, its boundaries are the following:—to the right side, vena cava; to the left, aorta; behind, venæ cavæ hepaticæ; in front, vena porta; and inferiorly, hepatic artery, which separates it from the pancreas. This lobule, known to the older anatomists as the posterior portal eminence, while the lobulus quadratus was termed the anterior, is attached to the liver by two distinct roots,—a posterior, which winds round the vena cava, generally converting the fissure, in which it is contained, into a complete canal; and an anterior, which is now generally known as the *Lobulus Caudatus*.

LOBULUS CAUDATUS, always very indistinctly marked, is merely that portion of the liver circumscribed between the depression for the kidney behind, and those of the colon and duodenum in front, while the lobulus dexter is that portion constituting the thick posterior angle lying behind the renal fossa.

The liver is invested by two tunics, an external serous; and an internal, which may be considered as its proper capsule, fibro-areolar. The first is derived from the peritouæum, which with slight exceptions, forms nearly an entire investment for it; covering it completely, with the exception of its posterior border, the grooves for the gall-bladder, and the great fissures over which it is inflected, and the small spaces intervening between the ligaments. The extensive sheet of serous membrane with which it is clothed, has naturally a tendency to facilitate those motions, to which the organ is subjected in the alternating movements of inspiration and expiration, each of which it must necessarily follow, from its close attachment to the diaphragm.

The proper fibrous capsule, was first described by Glisson, who conceived it to be muscular; it is best observed on those parts of the liver where the serous coat is deficieut, and here it will be found to be thin, but strong, and difficult to be detached for any extent from the hepatic structure, owing to processes which are very freely sent into it at all points, especially at the transverse fissure, where it forms complete tubules or sheaths (vaginal) around the several vessels and ducts as they enter this depressiou; and is ultimately expended in constituting investing capsules (lobular) for the small lobules of which the organ is composed, being here remarkably thin, but vascular, owing to the numerous filaments of the hepatic artery which ramify in its substance. To form a proper idea of those lobules, they should be examined in the boiled liver of a pig, where they are large enough to be detected with the naked eye; they always present a different aspect according as they are cut in the vertical or transverse direction; in the former, being leaf-shaped, the margin not presenting however, an uniform appearance; while in the latter, they are polyhedral, having sometimes four, five, or six angles. Each lobule is enclosed in a process of the capsule, which embraces it completely, except at its base, where it is deficient, and where it rests on a small vein—the sublobular. The lobules are not exactly in contact with each other, narrow intervals (iuterlobular fissures) being left between their adjacent margins; but when more than two are in juxtaposition, this interval is increased in size (interlobular space). A lobule consists of a series of granular cells, interspersed with branches from the portal, and hepatic veins, hepatic artery, and according to some, the hepatic ducts, all of which must now be severally examined.

Hepatic Artery.—A large branch of the cœliac axis, which passes upwards to the liver, between the layers of the lesser omentum, lying to the left side of the duct and portal veiu; and at the distance of about an inch, or perhaps a little more, from the transverse fissure,

divides into two branches, a right, and a left, the former being the larger, as it usually gives off a small branch, the cystic, to the gall-bladder, while it also has to supply the larger portion of the liver. Both branches penetrate the fissure at its extremities, between the duct and vein, and break up into a number of minute branches, which pass into the interlobular spaces, and then ramify on the capsule, until they ultimately reach the lobule, which they are destined to supply; these several branches are known by the name of the vaginal, interlobular, and lobular; but of the last, only a few twigs penetrate the lobule, apparently for its supply, their *effête* blood afterwards mingling with that of the porta, to be ultimately removed by the hepatic veins. The function of the artery, is of course that of nutrition, for the various tissues of which the organ is composed.

Vena Portæ, is a very large trunk, deriving its blood principally from the mesenteric, and splenic. From the point where it is formed between the head of the pancreas, and aorta, it passes upwards and to the right side, and when between the layers of the lesser omentum, lies on a plain posterior to, as well as between the artery and duct. Like the former, its primary division is into two branches, which again subdivide into vaginal, interlobular, and lobular; the lobular not only ramifying on the lobule, but also perforating its capsule, and forming, within it, a close and complicated venous plexus, from which the *bile* is derived, by exosmotic transudation; a subject to which we will again have occasion to revert; after the elimination of this secretion, the residual portion of its blood is conducted by a series of small branches to the centre of the lobule, where uniting they form a trunk, to which the name *intralobular* has been applied, and this ultimately emerging at the base of the lobule, opens into the sublobular vein; again, the veins, by continuously uniting with each other, and increasing in size as they proceed, form larger trunks (venæ cavæ hepaticæ), which at length pour their blood by three or four large orifices into the vena cava, as it grooves the posterior edge of the liver. Transverse sections of the liver, made from above downwards, will clearly demonstrate the gradual increase in capacity in those vessels, as their cut surfaces continue patulous, and have no tendency to collapse.

Hepatic Ducts.—According to Mr. Kiernan, these commence from a complicated biliary plexus, in the centre of the lobule, and pass out to the surface, on which they again ramify, before they enter the interlobular fissures, to anastomose with each other at the interlobular spaces, until, by repeated junctions, they at length terminate in forming the right and left hepatic ducts, which emerge from the portal canals, at either extremity of the transverse fissure.

The researches of succeeding observers have however, rendered the existence of this biliary plexus questionable, and it is now more generally supposed that they do not perforate the lobule at all, but terminate in blunted and cæcal expansions in the interlobular spaces, presenting at this point an irregular tuberculated appearance, arising from pressure on the cells, by which the duct is supposed to commence. And again, it has been thought that the lobule itself is composed of a number of cells, the active agents in the elimination of the biliary secretion, and that these, sometimes nucleated and sometimes the reverse, are arranged with a certain degree of regularity, in a species of linear direction, around the intralobular vein and its formative branches, which occupy the centre of the lobule. It is at this point, the elimination of the fluid is conceived to commence, and to be thence propagated from cell to cell, which sometimes are found to communicate for its more ready transit, until it reaches the surface, where it is poured into the interlobular spaces by the bursting of the cell, to be absorbed by the cæcal extremities of the biliary tubes, which pursue the course already indicated, and terminate in the right and left hepatic ducts, at the extremities of the transverse fissure. After proceeding downwards for about an inch and a half, these ducts unite to form the common hepatic, which, after a course of nearly the same distance, is joined by the cystic, constituting the *ductus communis choledochus*, which passes downwards, backwards, and slightly to the right side, until it reaches the posterior and internal border of the duodenum, which it perforates about its middle, and opens on its internal surface, near its lower angle. The relations of the right and left hepatic ducts, from their emergence to their point of union, present nothing remarkable; they are concealed by a quantity of loose areolar tissue, and the branches of the artery, and vena portæ, and but little difference appears in their size. The common hepatic duct, formed by their union, rests on the vena portæ, and lies between the layers of the lesser omentum, having the hepatic artery above, and to its left side. The ductus communis choledochus has the same relations above, but it soon emerges from between the layers of the gastro-hepatic omentum to rest upon the right crus of the diaphragm, where it is covered by the superior transverse portion of the duodenum; it is next found between its vertical division, and the head of the pancreas, which it deeply grooves, and ultimately runs obliquely between the coats of the gut for about an inch before it opens on its mucous surface, having been previously joined by the pancreatic duct, the papilla indicating its orifice, being always very perceptible, when examined under water. Experiment, however, will prove the impossibility of forcing

fluid from the gut into the duct; but the duodenum may be very easily distended from the duct.

GALL-BLADDER, can only be regarded as a diverticulum from the hepatic duct, and is the reservoir into which the bile is poured when not required. In size it is very variable, being usually as large as a small pear, and very similar to it in shape; its base protrudes beyond the free margin of the liver, so as to lie in contact with the abdominal wall, below the cartilage of the ninth or tenth rib, and to the right side of the rectus; while superiorly, it corresponds to the liver, which is grooved for its reception; and inferiorly, it rests on the superior transverse portion of the duodenum, and right angle of the colon, which are generally stained of a greenish hue by its transudation. It terminates, superiorly and posteriorly, in a constricted neck, which presents a remarkable curvature similar to the letter S, the mucous membrane being thrown into a large valve at each curvature, with their free margins turned towards each other, but a small interval exists between them, which is always more or less dilated. At the termination of the neck, the cystic duct commences; it is usually of very small calibre, and contrasts strikingly in its size with that of the common bile duct, which is generally as large as a goose-quill; as it passes downwards, and to the left side, it unites, after a course of about an inch and a half, with the common bile duct at a very acute angle, the mucous membrane again forming a well-marked valve at the point of junction. It lies between the layers of the lesser omentum, on the vena portæ, and to the right side of the cystic artery, which always gives off a small branch for its supply.

The structure of the biliary ducts, and gall-bladder, is precisely similar: they have three coats,—an external or serous, a middle or areolo-fibrous, and an internal or mucous. The peritoneal tunic is not complete, but is deficient altogether on the lower portion of the common biliary duct; the upper portion, with the cystic, only borrowing a partial investment from the lesser omentum; the gall-bladder is covered generally only inferiorly, the serous membrane simply binding it to the fossa in the liver, but sometimes it has been found forming a species of mesentery for it, and embracing it almost completely. The areolo-fibrous tissue which constitutes the middle coat is strong, but very lax in its character; but in the gall-bladder, it is intersected by several dense cord-like fibres, which form elevated ridges on the mucous membrane internally, their apparent use being to preserve the shape of the viscus, and counteract over-extension. The mucous lining is derived from that of the duodenum; it is thin, and presents numerous follicles, irregularly arranged in the ductus communis choledochus, and hepatic ducts; but constituting two dis-

tinct vertical rows, in the smaller tubes. In the gall-bladder, it is also follicular, and the depressions are so very numerous as to give it the appearance of an affection sometimes seen in the skin,—cutis anserina. We have already alluded to the two large valves, that are found in its neck; in addition to these, a great number, but much smaller in size, exist in the cystic duct; these never observe the same direction, but may be transverse, vertical, or oblique, sometimes amounting to nearly twenty in number, and occasionally conferring on the interior of the tube a kind of spiral appearance; they seem to offer an equal opposition to the ingress or egress of the bile into and from the gall-bladder. In the common biliary and hepatic ducts, there are, properly speaking, no valves, and any excrescence that may appear on the mucous membrane is purely accidental. A large fold, however, is always found at the confluence of the cystic and hepatic ducts, and this is prolonged for some distance into the ductus communis choledochus; while another likewise exists at the junction of the right and left hepatic, but this is always much more limited in extent.

In order to account for the mode, by which the bile escapes from the gall-bladder, for the purpose of mingling with the food, at the moment it is required, two theories have been advanced, the one mechanical, and the other physiological. In the first instance it has been presumed, that the distension of the superior transverse portion of the duodenum, as the alimentary mass passes through it, naturally presses the gall-bladder against the inferior surface of the liver, and thus expresses its contents, which reach the inferior transverse portion, precisely at the same time as the food attains the same spot; while in the second instance, it has been argued that the middle coat of the gall-bladder, which we have described as fibrous, is really muscular; if this latter assumption is correct, it is easy to conceive, that as both the gut and the gall-bladder are supplied by the same system of nerves, the same exciting influence which induces the contraction of the one, will as a natural consequence be propagated to the other, with of course the production of a similar effect.

The bile elaborated from the liver, has been very fully analysed by Gmelin; the result of his investigations may be briefly stated, as showing:—1. A substance, with a peculiar musky smell. 2. Fatty material, cholesterine; oleic, and margaric acids. 3. Cholic acid. 4. Biliary resin. 5. Taurin, or biliary asparagin. 6. Picromel. 7. Yellow colouring matter. 8. Extractive matters, osmazome, ptyaline, &c. 9. Casein, an albuminous matter, and mucus. 10. Bicarbonate of soda, carbonate of ammonia, acetate of soda; oleate, margarate, cholate, sulphate, and phosphate of potash and soda; chloride of sodium, and phosphate of lime. This fluid performs several important functions

in the animal economy; thus, it decarbonizes the blood, saponifies the fatty matter of the chyle, also animalizes it, separates this last product from the chyme, stimulates the intestines to throw out their peculiar secretion, excites their peristaltic action, and in some measure deodorizes the excrementitions residual portion.

The liver is developed by a conical protrusion from the hollow intestine, and during the first month of intra-uterine life is one-half of the weight of the entire body; but from this period it ceases to enlarge with the same rapidity, while the other organs rapidly increasing, the disparity is reduced from one-half to one-eighteenth at the time of birth, when an actual diminution appears to take place in its size, particularly in its left lobe, supposed to depend in a great measure on the obliteration of the umbilical vein, which deprives it of the great mass of nutrition which it received in its fœtal condition. To understand this clearly, it will therefore be necessary, to give a brief sketch of the fœtal circulation, and the changes which it undergoes, to assimilate it to that of the adult.

Fœtal Circulation.—During the period of intra-uterine life, when the respiratory function is not yet existing, the oxydation of the blood must depend upon the agency of some other organ than the lung, and this organ is known to be the *placenta*, an extensive structure which occupies generally the upper part of the uterus, not exactly coeval with the first existence of the embryo, but appearing to be formed completely, about three months after conception, by the gradual concentration of the villosities of the chorion, at one particular point. In it, ramify the umbilical arteries of the fœtus, carrying at that period venous blood, the capillaries in which they terminate, being remarkable for their minute size, and the tenuity of their coats. These are frequently brought into contact with the uterine vessels, which at this period approximate closely to the inner wall of the cavity, and are equally conspicuous for their tortuosity, extreme calibre, and delicacy of their tunics. The mutual approximation of the maternal and fœtal vessels, thus favoured by their particular construction, permits an exosmotic and endosmotic action to proceed, removing the *effête* products from the one, and imparting the vivifying principle to the other. Divested in this manner of its impurities, the blood is taken up by the radicles of the umbilical vein, by which it is carried through the umbilicus of the infant, which is at this period patulous, to the horizontal fissure of the liver, in which the vein passes backwards, as far as the transverse fissure. At this point it throws off three branches to the left lobe, and a single one to the right; the latter becoming directly continuous with the vena portæ, the circulation of which at this time is only imperfectly established, so that in fact the right branch of the umbilical vein

supplies the right lobe, by means of the terminal branches of the porta. Reduced considerably in size by throwing off these offsets, the umbilical vein continues its course backwards, under the name of the *ductus venosus*, and unites with one of the venæ cavæ hepaticæ, by which its contents are ultimately poured into the ascending cava, and by it conveyed into the right auricle of the heart. In the description of the heart itself, it has been already explained, that at this period an aperture (*foramen ovale*) exists in the septum auricularum, and that this is provided with a peculiar structure (*Eustachian valve*) which has a tendency to direct the caval blood directly from the right into the left auricle, from which it passes into the adjacent ventricle, to be propelled into the arch of the aorta; by the three great branches which spring from the upper portion of that vessel it is next conveyed to the head, neck, and upper extremity; and having supplied these several parts, the *effête* blood is carried back by the superior cava to the right auricle, not mingling with that of the inferior cava, but passing directly through the auriculo-ventricular opening into the right ventricle; from which it is propelled into the pulmonary artery, a small portion proceeding by its right and left branches to the lungs, but the greater part is carried by the *ductus arteriosus* to the arch of the aorta, which it joins a little below the junction of its transverse with its descending portion, and there, mingling with the residue of the purer stream which was more than sufficient for the head and neck, it proceeds downwards through the great arterial trunk to its bifurcation into the common iliacs; passing through these, to their division into external and internal iliacs, a part proceeds through the former for the supply of the lower extremity, while the remainder, the larger portion, is carried by the latter, the hypogastric of this period, along the side of the bladder up to the umbilicus, through which it emerges, and then, coiling around the umbilical vein, reaches the placenta, to submit its contents to the vivifying process of that structure.

It will be observed from this brief sketch, that there is only one organ in the fœtus that receives pure blood, and this indeed only partially—the left lobe of the liver—that of the right, being more or less tinged with that of the porta. It will be also borne in mind that at the point where the umbilical vein discharges its contents into the cava, that vessel is more or less filled with the *effête* blood of the lower extremity, and hence naturally ensues a mixed fluid, which, pursuing the course already indicated, is destined for the supply of the upper portion of the trunk; while the lower receives a stream still more degenerated, owing to its admixture with the returning venous blood of the former. The appearance presented by the infant at birth, serves to confirm in a great measure the correctness of

this scheme of the circulation, as there exists a marked disparity in the development of its upper and lower parts, shewing the excess of nutrition which the former received, in comparison with that of the latter; the enormous size of the liver, too, would aid in strengthening the theory, and the partially oxydized condition of the blood at this period of existence, can be only compared to the state of the circulation as exemplified in the reptile. But with the first inhalation of the atmospheric air, a change rapidly ensues; the lungs expand and protrude the elastic walls of the thorax, at the same time forcing the diaphragm downwards, thus causing a species of vacuum, to which the blood, gorging the right side of the heart and pulmonary trunk, finds a readier access than pursuing its original course through the ductus arteriosus, which now becomes useless, and compressed by the left bronchus, is gradually converted into a ligamentous cord. Ramifying over the air-cells, and receiving its vital properties from their contents, it is again brought back to the heart by the pulmonary veins, which thus distend the left auricle with their blood, at the same moment that the right is filled with that from the two cavæ. The equable pressure thus produced on the valvular opening of the fossa ovalis, either causes its complete occlusion, or at least prevents any admixture taking place between the two currents. Independent existence being now established, the ligature constricts the umbilical vessels, thus severing the bond of union that connected fœtus and parent; while the portal circulation, assuming its proper activity, renders useless the ductus venosus, which is at last obliterated completely by the pressure of the diaphragm as it gradually descends.

SPLEEN.

The Spleen in its normal condition occupies the left hypochondriac region; but in cases of enlargement, to which it is very liable, it may either press over to the right side, or directly downwards. In its natural state, it weighs from three to seven or eight ounces, and is similar in figure to an ellipse divided longitudinally; it accordingly presents for examination, an internal, and an external surface, and a circumference. The external surface is convex, and lies in contact with the cartilages of the four inferior ribs, from which however, it is separated by the fleshy fibres of the diaphragm; the internal is concave, presenting nearly in the centre a deep depression, known as the hylus, through which the arteries enter for its supply, and is in relation with the great extremity of the stomach, splenic vessels, and vasa brevia, gastro-splenic omentum, tail of pancreas, left suprarenal capsule, and occasionally with the left lobe of the liver. The superior

part of its circumference, corresponds to the diaphragm; the posterior, to the left kidney; the inferior, to the angle of the colon; and the anterior, to the stomach. It is kept in position by one layer of peritonæum from the diaphragm, by another from the large end of the stomach (gastro-splenic omentum), and by its own vessels, and the pressure of the adjacent parts.

The spleen, like the liver, has only two coats—an external, serous; and an internal, fibrous.

Serous Coat, invests it completely, except at the hylus, where it is deficient, for the passage of the vessels for its supply, conferring on it a smooth surface externally, which permits it to glide with facility, and accommodate itself to those changes of position to which it is so constantly liable from the condition of the stomach, whether distended or otherwise. This tunic is closely adherent to the fibrous, from which it can with difficulty be detached.

Fibrous Coat, is thin and transparent but strong, and not only closely united to the peritoneal, but likewise to the spleen itself, into which it sends innumerable prolongations, which interlace with each other in every possible manner, converting the entire organ into a series of cells, which appear to communicate with each other, only in certain proportions, and not completely. On arriving at the hylus it does not terminate abruptly, but forms sheaths for the vessels, which continue to inclose them, in all their minute ramifications, to their ultimate termination.

The spleen must be considered as composed of several lobules, and this may be distinctly shown by injection. The artery which supplies it, is very large, and before it penetrates into its substance usually subdivides into five or six branches; each may be injected with a different coloured fluid, which will only tinge its own immediate compartment, unless too great a force be employed, when they may become blended together by the consequent rupture. The manner in which the arterial capillaries terminate, is not clearly understood; it is however generally believed, that they are tufted or pencillate, discharging their blood into the cellwork of the spleen, by a kind of exudation; these cells being filled with small pulpy masses, the ulterior ramification of the vein constituting a species of venous erectile tissue, which pervades the entire organ. There can be no question but the veins communicate with the cells, much more freely than the arteries—a fact which may be easily proved on endeavouring to distend the spleen by a column of water of similar weight being introduced by either vessel, when it will be found that its maximum pitch of distention will be accomplished much more rapidly from the vein than from the artery.

Malpighian Corpuscles.—The existence of these small bodies in

the human subject has at one period been denied, at another affirmed. They are certainly very evident in the ox, sheep, and pig, lying in contact with the venous cells, and occasionally appearing to be connected to the arteries by short stalk-like processes. They were looked on by Malpighi as of some importance, by effecting certain changes in the splenic blood, an opinion which however, requires confirmation.

The spleen is a lymphatico-vascular gland, and accordingly has no special ducts. In the fœtus, it is visible about the end of the second month, being then very small, and maintaining a comparatively diminutive size during the entire of intra-uterine life. With respect to its functions there is, perhaps, no organ in the entire human body, concerning which so many different theories have been mooted, to be as frequently shown to be erroneous. Thus it has been supposed to be a balance for the liver (Doellinger); a receptacle for the blood in the distended condition of the stomach during digestion (Dobson); a reservoir for the fluids of the stomach, which afterwards passed from it to the kidneys by secret channels (Home); to confer the red colouring matter on the corpuscles of the blood (Hewson); to perform the function of a secreting gland (Mayer); to equalize the hepatic circulation (Carpenter); and a laboratory in which the white corpuscles are converted into red (Donne). These are only a few, out of the very numerous views that have been at various times hazarded, with respect to the functions of this organ; but they are quite sufficient to show the great uncertainty that prevails, with regard to its true use in the animal economy. Dalton, the American physiologist, has recently shown, that its removal from the lower classes of animals is always followed by a ravenous propensity for food, and a ferocity of temper, quite at variance with the quiet disposition of the animal previous to having been made the subject of experiment. Its enlargement in certain diseases of the liver, would seem to prove that it is influenced in some measure by the condition of that gland, while again its enormous increase of size in intermittent fever, would tend to establish the fact, that it is more or less concerned in equalizing the circulation generally. Amongst the many speculations on the uses of this gland, it has frequently struck us, that the true one has been completely overlooked; during the quiescent moments of sleep, when the activity of the circulation is more or less in abeyance, some receptacle becomes absolutely necessary, for the purpose of storing the excess of blood during the period of repose, and from its acknowledged powers of rapid expansion, the spleen would appear to be admirably calculated to accomplish this office. Still, it must be admitted that its peculiar properties require further elucidation, and that any opinions, which have hitherto been broached concerning it, will scarcely bear the test of a rigid scrutiny.

PANCREAS.

This viscus is placed transversely in the abdominal cavity, but at the same time so obliquely, as to occupy the left hypochondriac, the epigastric, and umbilical regions. In colour it is pinkish grey, and it appears to be divided on its surface into a series of irregular lobules, faintly mapped out by a number of wavy lines, while in figure it is flattened and triangular, and hence its division into a head, body, and tail. The first, or the head, which is thick and rounded, lies towards the right side, in contact with the concavity of the duodenum, but is separated in some measure from it by its own duct, the ductus communis choledochus, and pancreatico-duodenalis artery. The tail, much smaller, and tapering to a point, corresponds to the hollow of the spleen ; its posterior surface, concave, rests on the right crus of the diaphragm, the portal and caval veins, semilunar ganglion, aorta, left crus, with the splenic and mesenteric veins, left suprarenal capsule, and kidney; also partially, on the superior mesenteric artery, which tilts forwards its inferior margin; its anterior surface, convex, is in relation with the stomach, but is separated from it by the ascending layer of the transverse mesocolon, and sac of the omentum; its superior margin, nearly straight, corresponds to the superior transverse portion of the duodenum, lobulus Spigelii of liver, hepatic and splenic arteries—the latter grooving it deeply—and cœliac axis; and its inferior, to the second transverse portion of the duodenum, superior mesenteric artery, which emerges from beneath it, and attachment of root of mesentery; this margin is sometimes rendered very irregular by a process which springs from it near its head, passes downwards and to the left side, beneath the superior mesenteric artery, and after embracing it, again becomes continuous with the body; this has been called the *lesser pancreas.*

The pancreas crosses the spinal column, opposite the first lumbar vertebra, and is very firmly fixed in its position, by the cœliac axis and superior mesenteric arteries, between which it is wedged; as well as by the ascending layer of the transverse mesocolon, which confines it closely to the back part of the abdominal cavity. In order to examine its duct (*canal of Wirsung*), the anterior surface of the gland should be very cautiously removed, from one extremity to the other, to a depth a little beyond its middle, the duct, when reached, being recognized at once by its milk-white colour, which contrasts strikingly with the general hue of the gland. The duct usually commences in the tail, by a double origin, and is very small at first, but gradually increases in size as it approaches the head; at this point, it bends downwards and to the right side, and opens either into the

duodenum directly, or unites very obliquely with the ductus communis choledochus, immediately before that duct perforates the gut; occasionally, a second duct is present from the lesser pancreas, and this may either terminate in the ordinary manner, or by a separate opening into the gut. With respect to its coats, they consist of two; an external, which is very thin, scarcely deserving the name of fibrous, and an internal mucous, derived from the lining membrane of the ductus communis choledochus, but this is so very fine that it seems analogous to a serous membrane; its proper character is, however, established by the existence of certain mucous follicles which are found within it, as well as by the epithelium which covers it. The gradually increasing calibre of Wirsung's canal, from its commencement to its termination, is accounted for by its receiving successively the smaller ducts, from the glandules of which the pancreas is composed, all of which open into it separately, and give it the appearance of a centipede, to which it has been not inaptly compared.

In structure, the pancreas closely resembles the salivary glands, already fully described, having like them, its lobules separated by fine fibrous tissue, each containing its follicles of secretion, with its accompanying cell apparatus for the elimination of its peculiar fluid, which is derived from its proper vessels, the splenic, superior mesenteric, and hepatic. A partial analogy likewise exists in the secretions of the pancreatic, and salivary glands; the pancreatic contains more solid ingredients, as albumen and caseine, has an acid reaction, and no sulpho-cyanate of potassa; while on the contrary, the saliva possesses the sulpho-cyanate, as well as an abundance of salivin and mucus, which are sparingly found in the pancreas. It is extremely difficult to assign any decided use to the pancreatic secretion, owing to the number of theories respecting to it—thus, it has been said to be of service in diluting the bile, in saponifying the fat globules found in the chyle, and modifying the acidity of the gastric juice, on reaching the duodenum. The quantity secreted in about twelve hours, from a large dog, amounted to about eight drachms (Tiedemann).

SUPRARENAL CAPSULES.

Found in both hypochondriac regions, and as their name implies, generally in close apposition with and above the kidneys; are conical in shape, but flattened from before backwards, and of very variable size in different subjects, as well as at different periods of life. If the kidneys are normally situated, the suprarenal capsules are always more or less excavated, in order to fit on their upper lobe, like a helmet on the head; their superior extremity, truncated, is in contact on the right side with the liver and on the left with the spleen; and to

both those organs they are not only attached by condensed areolar tissue, but are likewise overlapped by them; while they rest on the crura of the diaphragm, and semilunar ganglia, the latter lying slightly internal to them, and freely supplying them with large and numerous filaments.

In addition to a thin fibrous membrane analogous to that of the kidney, which forms its outer envelope, these bodies are composed of two distinct structures,—an external or cortical, and an internal or medullary. The first, of a yellowish colour, and consisting of a series of fibres arranged parallel to each other, is formed both by the arteries, with which it is very copiously supplied, and by cœcal tubules of basement membrane, which are found on examination to contain cell germs, and fat cells, in various stages of development. The medullary tissue, is principally constituted by a dilated venous plexus, which receives the blood from the arterial branches already alluded to, and a quantity of minute cavities, containing a reddish, gray fluid—all bound together by a proper parenchyma, in which are interspersed numerous cells displaying different degrees of maturity. With respect to the cavity which is said to occupy the interior, careful observation has rendered the fact of its existence extremely doubtful, and the recess which sometimes does exist would appear to be simply the result of rough manipulation, which breaks down the delicate erectile tissue, of which the interior is principally composed.

In the fœtus, the suprarenal capsules are relatively much larger than in the adult; they are fully apparent during the second month of intra-uterine life, and at this period exceed the kidney both in size and weight; but after this, a change ensues, the kidneys growing rapidly, while the capsules remain stationary; so that at birth, the one is three or four times larger than the other. It is from the foregoing facts, that the older physiologists assumed the idea, that these organs are in some way or other connected with the urinary secretion during the fœtal condition. Their high nervous and vascular organization, is indeed a strong presumptive proof that they do perform some important part in the animal economy, but as yet very little light has been thrown on their true function. That they may be of some use as diverticula, during renal congestion (Carpenter) seems to be very probable, and appears to be the most rational of any of the conjectural theories that have as yet been advanced on the subject. Doctor Addison has however, discovered one very singular fact with respect to their pathological condition, and that is the association of bronzed skin, with tubercular deposit in their interior; but how this effect is produced, still requires further explanation. It is however, a curious fact, that malposition of the kidney, or atrophy of that organ, never has any influence in altering the situation of the suprarenal capsule, or diminishing or increasing its ordinary size.

KIDNEYS.

Both those organs are situated in the lumbar regions on either side, and correspond in position to the two last dorsal, and two first lumbar vertebræ; with this difference however, that the left is always placed a little higher than the right, which is always more or less depressed by the liver. They do not lie exactly parallel to each other, but converge superiorly, and diverge inferiorly, and are so disposed that while one surface looks forwards and outwards, the other looks backwards and inwards. In size, they are very variable, their usual weight being from three to four ounces each, while in shape they resemble very closely a French bean. In order to understand more properly their relations, we will give them an anterior, and a posterior surface; an external or convex, and an internal or concave margin; and a superior, and an inferior extremity.

The posterior surface, which is recognised immediately by its flatness, as contrasted with the anterior, rests on the quadratus lumborum, from which it is separated by the anterior layer of the transversalis aponeurosis; on the ilio-scrotal, and last dorsal nerves; and on the psoas magnus and posterior edge of the diaphragm, which intervenes between it and the last ribs. The anterior surface, very convex, corresponds on the right side, to the ascending colon, vertical portion of duodenum, and under surface of the liver, which overlaps it superiorly; and on the left, to the descending colon, and mass of the small intestines. The superior extremity of the right, is in relation with the liver, but separated from it by its corresponding suprarenal capsule; while that of the left corresponds to the spleen, but divided from it by the same organ; again, on the right the cœcum lies immediately below it, and on the left, the sigmoid flexure. Their external margin, which is very convex, corresponds to the abdominal wall; while their internal, which is concave, has internal to it, the cava on the right side, and the aorta on the left; the depression on this border, which is more deeply notched posteriorly, than anteriorly, has been termed the hylus, and affords the passage to the renal vein, artery, and ureter—those several parts holding the position as stated to each other, both from above downwards, and from before backwards, except on the left side, where the vein is occasionally found behind the artery. These organs are retained in position by the peritonæum, which is reflected over them, by the fatty tissue in which they are bedded, by the large blood-vessels which pierce them, and by the pressure of surrounding parts. Their *coats* are three in number—an external, or serous; a middle, or cellulo-adipose; and an internal, or proper fibrous.

Peritoneal Coat, derived from the abdominal serous membrane, is very incomplete, merely covering it anteriorly, and partially on its margins, and can be removed from it without much difficulty; its use apparently being, to bind the kidney to the posterior wall of the abdomen.

Adipose Coat, is developed very sparingly in the human subject, but is generated most abundantly in quadrupeds; it is always very irregular in its distribution, but is usually found in greater quantity on the posterior, than on the anterior aspect of the kidney.

Fibrous Coat, forming the proper capsule, and composed of a thin but strong tissue, completely invests the whole organ, and on reaching the hylus, forms sheaths for the several vessels that pass in through it, becoming ultimately continuous with the fibrous envelopes and septa within the kidney. It likewise throws off numerous processes externally, that are blended with the fat, and that assist in maintaining the kidney in its proper position.

Either kidney may be now removed from its position, and a longitudinal incision made completely through it, from its convex to its concave border, taking care however, that the knife is carried directly through the middle, so as to expose more fully all the constituent parts, when the cut surfaces must be washed, beneath a stream of water, and examined. In the section of the healthy kidney, made in the manner just described, two structures, very different in their outline and general appearance, are brought into view,—the one lying external, of a reddish colour, called the *cortical*; and the other disposed in triangular masses of a pale, livid hue, termed the *medullary*. Those masses, which vary from six to twelve in number, and were first described by Malpighi, have since been known as the pyramids of that anatomist. The bases of all of them, are turned outwards towards the cortical substance, thin processes of the latter structure being sent down between them, so as to isolate them from each other, while they all terminate internally, in a blunted extremity, termed a mammilla or papilla, each lobule thus constituting in fact, a separate kidney in fœtal existence, an arrangement which is persistent in a great majority of the lower classes of animals, during the entire period of their existence. Bellini, and Berlinghieri were the anatomists who first distinctly pointed out that those pyramidal masses were composed of a series of uriniferous tubules, and hence they are generally known by the name of the former (tubes of Bellini); but it was reserved for Ferrein, to give the true theory with respect to their ultimate disposition. According to him, each single tubule of Bellini, consists of an aggregate of smaller ducts, amounting in the majority of instances to one hundred, in consequence of their dividing in dichotomous order as they advance from the apex to the base

of the Malpighian pyramid, while all are bound together by a thin fibrous sheath. On reaching the cortical structure, he describes them as passing into it, and becoming twisted and convoluted like the tendrils of a vine, until at last each terminates in flask-like extremities, or in forming a loop with an adjacent one. If we now direct our attention to the cortical substance, we will observe that it invests the whole kidney, to a depth varying from a quarter to half an inch, sending as has been already observed, processes inwards between the several tubular cones. In structure, it is composed of the ramifications of the renal artery, vein, and convoluted tubes already alluded to; but in order properly to understand its arrangement, a few brief remarks must be made, with respect to the distribution of those several vessels.

The Renal Artery, an extremely large branch of the abdominal aorta, before entering the hylus of the kidney, generally breaks up into five or six divisions, which on penetrating the organ, pass outwards between the conical masses, sending off a few long, straight branches, which ramify between, and run parallel to the ducts of which they are composed; while the principal trunk continues its course, towards the external or cortical structure, on reaching which it divides into two distinct sets of branches, one being destined for the supply of the gland, its *effête* blood being taken up by the corresponding capillary veins; while the other (the afferent vessel) pursues its course to the flask-like dilatation of the convoluted tube, the wall of which it perforates, and becoming dilated, forms a complicated plexus within its cavity (the Malpighian tuft). Its dilatation and plexiform arrangement, within the expanded extremity of the duct, naturally produce a stasis of its contained blood, a condition most favourable for the exudation of its more fluid contents; and this is further increased by the small size of the efferent vein, which emerges from the dilated tube, by an orifice much more contracted than that by which the artery had entered, an arrangement calculated to maintain a state of congestion admirably adapted for the exosmosis of the serous portion of the blood,—or in other words, for the watery constituent of the urine, which is afterwards urged through the tube, by the continued action of a series of cilia, which are constantly in motion, and propelling it onwards. The efferent vein, which emerges from the pouch, removing the *effête* blood of the Malpighian tuft, has been compared by Mr. Bowman to the portal vein of the liver; it unites almost immediately with the capillary vein of the nutritive artery of the gland, and the common trunk constituted by their union forms frequent plexuses with the convoluted uriniferous tube of Ferrein; and these vessels (we allude to the duct, and vein) holding fluids of such different degrees of density,

within their cavities, transudation is the natural result from their mutual contact one with the other (Dutrochet), and by this means the more solid contents of the urine are eliminated from the venous blood, and passing into the duct, mingle with its aqueous contents. The fluid thus formed is conveyed downwards, through the several tubes, to the apex of the Malpighian pyramid, and is distilled in minute quantities, from the small orifices of the papillæ, into the calyces, which we will presently proceed to describe.

The foregoing is the explanation given by Mr. Bowman; but although undoubtedly accurate in the great principles he has laid down, still there is reason to believe that in some of the details he is partially incorrect. This we conceive has been fully shown by Mr. Hassall, who, as a microscopic anatomist, ranks amongst the first of the present day, and the truth and fidelity of whose observations in this especial department we have had repeated opportunities of testing and verifying. He expressly declares—and in this view we most distinctly concur—that the Malpighian plexus does not lie actually within the flask-like, or dilated, extremity of the convoluted tube, but is always separated from its cavity by the basement membrane, the interior of which is studded with a number of cells, for the purpose of eliminating the watery constituents of the urine; but he admits, however, that this plexus is covered by a dense fibrous adventitious capsule. The very idea of distinct perforations for the afferent artery, and efferent vein, although at first sight calculated to impress us with the feeling that it is correct, both from its extreme simplicity and its peculiar adaptation for the office it is called on to perform, is found on reflection so completely at variance with the system on which operations of a similar nature are conducted in other parts of the body, that we are led to coincide with the views suggested by Mr. Hassall, as being in accordance with facts well ascertained, and equally well established.

Calyces, small, cup-like cavities, with their open mouths turned externally, and embracing one, two, or three papillæ, of which they receive the contents, are composed of a thin but strong fibrous sheath externally, and lined by mucous membrane internally; in number they are variable, but generally average from six to seven, and they terminate towards the hylus of the kidney in a small, funnel-shaped process, which, uniting with an adjacent one, constitutes an infundibulum.

Infundibula, are short, thick tubes, and are almost invariably three in number—a superior, a middle, and an inferior. Of these the first is the longest, and the second the shortest. They are composed precisely of the same structures as the calyces, and their convergence at the hylus, and ultimate union, constitute the *pelvis*, of the kidney, or commencement of the ureter.

Ureters.—The urine, secreted from the kidney, is carried by the ureters to the bladder, the reservoir for its temporary reception. The ureters, are tubes from fifteen to eighteen inches long, and nearly equal in calibre to a goose-quill. As they pass downwards and inwards, towards the true pelvis, they rest upon the psoas muscle, on the bifurcation of the common iliac arteries into external and internal, with their accompanying veins, and on the obturator vessels and nerves. They lie behind the peritonæal sac, and are crossed at a very acute angle, while in the abdomen, by the spermatic vessels; while as they descend into the pelvis, they pass behind the last coil of the ileum, on the right side; and the sigmoid flexure, and superior hæmorrhoidal artery, on the left; they are next enveloped in the posterior false ligaments of the bladder, which conduct them to that organ, where they are crossed in front by the vasa deferentia; they then pierce the coats of the bladder, and, running for about three-quarters of an inch between them, open at the extremity of the base of the trigone by a valvular orifice. The ureters have three tunics—an external or peritonæal, a middle or fibrous, and an internal or mucous. The first of these, or the *serous*, is very imperfect, covering them only anteriorly, but still adhering to them with some degree of tenacity; the second, or *fibrous*, derived from the proper capsule of the kidney, invests them completely, is extremely dense, and also possesses much strength; it surrounds the pelvis at the hylus, and is prolonged into the substance of the kidney to form the external envelopes of the infundibula, calyces, &c.; the third, or *mucous* layer, is remarkable for its pale character and peculiar tenuity; it is merely a prolongation upwards from the internal coat of the bladder, which, after lining the ureters, is inflected in succession into the infundibula, calyces, uriniferous ducts, and ultimately into the convoluted tubes of Ferrein, where it terminates at those pouch-like cæcal processes already alluded to. In this latter situation, the ureters are lined by small epithelial cells with oval nuclei, but in the immediate vicinity of the flask-like dilatation these give place to the ciliated variety, which is again succeeded in those of the cortical structure, by the pavement form, angular and coarsely granular; in the tubes of the medullary structure they diminish in size, and display evident nuclei, surrounded by a very narrow border.

The Kidneys, exactly as in the lower classes of animals, are developed from peculiar embryonic structures, termed the Wolffian bodies, so called after the name of their discoverer. Those bodies make their appearance towards the end of the first month, but it is near the end of the second before the rudiment of the kidney is visible; during the third month, the kidneys continue to increase rapidly in size, while the Wolffian bodies diminish in equal ratio, so

that at birth scarcely a vestige of them remains. At the twelfth week, the kidney consists of from eight to twelve lobules, which are destined to form the future pyramids, and these are loosely connected together by lax areolar tissue, but afterwards become more firmly united by a condensation of this substance, so that at length the lobulated appearance is completely obliterated. The Wolffian bodies are highly vascular; they receive four or five large branches from the abdominal aorta, and their *effête* blood is returned to the cava by two large veins, the superior of which, with its corresponding artery, afterwards forms the renal vessels; and the inferior, with its accompanying artery, the spermatic. The Wolffian bodies are placed on either side of the spinal column, and are composed of a series of cæcal appendages, or pouches, which present a convoluted appearance, interspersed with numerous darker points, which are small plexuses of blood-vessels, closely coiled on themselves, the analogues of the future Malpighian tufts. The excretory ducts, with those from the kidney, and sexual organs, form a common canal, and this again, with that from the rectum, opens into the cloaca, or sinus urino-genitalis, the sides of which latter, by their gradual approximation and subsequent union, ultimately form a septum of division, between the rectum and genito-urinary organs; the urethra of the female is afterwards isolated from the vagina, by a similar process.

The Urine, the fluid eliminated from the blood by the kidneys, is of an amber colour, emitting a peculiar odour, and in health having a specific gravity of about 1·011. According to Berzelius, it is composed of :—1. Water; 2. Solid residue; 3. Urea; 4. Uric acid; 5. Lactic acid, lactate of ammonia, alcohol, and watery extract; 6. Mucus; 7. Sulphate of potash; 8. Sulphate of soda; 9. Phosphate of soda; 10. Biphosphate of ammonia; 11. Chloride of sodium; 12. Chloride of ammonium; 13. Phosphate of lime and magnesia; 14. Silicic acid. Besides removing these products from the blood, which by their deleterious agency might exercise an injurious influence on the body generally, the kidneys act an important part in equalising the circulation, by abstracting the excess of serum from the vessels, which would otherwise increase to an immoderate extent.

SECTION V.

NERVOUS SYSTEM.

Before proceeding with the descriptive anatomy of the nervous centres, and those parts with which they are in immediate connexion, we think it necessary to prefix a few preliminary remarks, on their structural peculiarities, and recognised divisions. The nervous system has been divided into two orders,—one, the *cerebro-spinal*, which includes the brain, and spinal cord, with the nerves emanating from or connected with them; and the second, the *sympathetic system*, consisting of a series of ganglia, extending in a continuous chain along the spine, from the base of the skull to the coccyx; the former having presidence over animal life, and connected by its nerves with the functions of sensation, motion, and those of the more special senses; while the latter maintains, originates, and governs the functions of organic life, its filaments being principally distributed to the internal viscera and glands. But although possessing structural differences and functional distinctions sufficient to form the basis of a perfect division, still throughout the human body, constant and intimate communications exist between the two systems, evidencing the mutual interdependence subsisting in their relations, as the exciters of that combination of actions which, taken in their widest sense, signify life.

Cerebro-spinal System.—Consists in structure of two very distinct elements—the one being grey, or cineritious; cellular, or secreting; and the other white, fibro-tubular, and conducting.

Grey, or Cineritious, Neurine is found in numerous situations, —as on the surface of the brain, in the optic thalami, corpora striata, crura cerebri, pons Varolii, medulla oblongata, and spinal cord, as well as in, and on the cerebellum. Its common constituents are—a granular base, granular cells, ganglionic corpuscles, and nucleated nerve fibres. The granular base exceeds the granular cells in the grey matter of the brain, but the latter predominate in that of the cerebellum, spinal cord, and tuber cinereum. The ganglionic cells are large granular bodies, containing pigmentary matter, with a nucleus and nucleolus, and an oily fluid; and possess the common character of being provided with caudate prolongations, in whatever situation they are examined; their shape is not, however, uniform in all parts of the nervous centres, as they are stellar in the locus niger of the crus cerebri, and pyriform in the cerebellum; or they may be triangular, as in the medulla oblongata; or large and irregu-

lar, with numerous prolongations, as in the spinal cord. It is believed by some physiologists that these caudate prolongations are connected with the conducting tubular structure.

Nerve Filaments, are small and nucleated, resembling the sympathetic fibres.

Fibro-tubular Structure.—In the brain, spinal cord, and nerves of motion, and special sensation, the tubules are unbranched and extremely slender ; but in the cerebellum, whilst they still are undivided, they become much larger, a character also observed in the posterior roots of the spinal, and sympathetic nerves. But it is in the motor nerves that these tubules exhibit the largest size, accompanied with the greatest amount of resistance. The nerve tubes of the brain and cerebellum, together with the nerves of special sense, have a remarkable tendency to become varicose when subjected to pressure, which seems to depend on the tenuity of their investing membrane, and on their containing a fluid matter, which collects at certain points, sometimes even producing rupture of the envclope. As it is almost impossible to isolate the fibres of the brain from the surrounding tissues for examination, those of the motor nerves are always selected as the type of the tubular tissue. A nerve tube consists of an investing membrane (*neurilemma*), which is transparent, homogeneous, and smooth, without a trace of fibrous structure, having within it a thin, elastic, white, albuminous layer (white substance of Schwann), which again incloses a thin, soft, semifluid matter, probably phosphorized fat, having little tendency to solidification, which is called the axis cylinder of Purkinje. In the white matter of the brain, numerous globules occur, forming the greater amount of the cerebral mass ; they are of all sizes, and resemble cells, with an oily consistence and colour.

Sympathetic System.—The nerves connected with this division present some peculiarities, being of a grey colour, soft, and exhibiting the formation of ganglia at intervals. They likewise possess two distinct elements,—the one, being the ordinary nerve tubule ; and the other, nucleated filaments, resembling the non-striped muscular fibre ; these Henle has named, gelatinous nerve fibres. Some difference of opinion has occurred with reference to the latter constituents, as to whether they were really portions of the nervous system at all ; but their origin and termination being similar to the true nerve tubes, as observed by Bidder, is quite sufficient to justify the affirmative.

The Ganglia, which are observed not only on the sympathetic, but in connexion with the cerebro-spinal system, contain three elements—namely, corpuscles (ganglionic), gelatinous filaments, and nerve tubules. Each ganglion has on its external surface a capsule,

derived from the external investing membrane of the nerve trunk, which sends sepimenta into its structure, so as to divide it into small compartments, each containing a separate and independent portion of nervous tissue. Internal to the capsule, the gelatinous filaments form a second investment, by being arranged in a continuous layer, whilst the centre is occupied by the ganglionic corpuscles, and nerve tubules; the latter, on entering, separate from each other, becoming twisted and interlaced in a serpentine manner amongst the ganglionic cells. The ganglia present externally, a great similarity to glands; and this resemblance is further increased, by the presence of a capsule, which sends its partitions deeply, isolating the lobules from each other. That they are connected with the secretion of some peculiar element would appear at least probable, as the tubular structure seems to stand in the relation of efferent ducts for the transmission of the eliminated product.

Origins of the Nerves.—They are conceived to commence by loops, and to have a similar mode of termination at their peripheral extremities; for in cases where the brain and spinal cord were absent, the nerves were observed to arise from a granular and cellular matter, by looped extremities. By some authorities it is imagined that the extremities are connected with the caudate prolongations of the ganglionic cells; but this opinion, appears to require further confirmation.

Development of Nervous Tissue.—The nerves appear to be formed by the fusion of primary cells, arranged in rows, thus constituting a secondary cell; and when a nerve can first be distinguished, it appears as a pale cord, with longitudinal fibrillation profusely nucleated, from which filaments can be detached, which also contain nuclei. These fibrillæ are pale, granulated, and hollow at this period; but after a time, a secondary deposit takes place on the inner surface of the cell membrane, of the secondary nervous cell; this deposit is fatty, and white in colour, giving the future opacity to the nerve. As the deposit increases, the volume of the nerve is augmented, and displays a double contour under the microscope, indicating a tubular character. The nuclei now disappear, but slowly, so that some few remain visible for a longer period than others, the cavity appearing to be filled up by a firm consistent substance, called the band of Remak; so that the adult nerve seems to consist of, first, the cell membrane; secondly, a white, fatty substance; and thirdly, the band of Remak.

COVERINGS OF THE BRAIN.

Are three in number,—namely, the dura mater, or *fibrous*; the arachnoid, or *serous*; and the pia mater, or *areola-vascular*, lying from superficial to deep, in the order enumerated.

Dura Mater.—In order to examine this membrane with the inclosed organ, the brain, a variety of modes have been adopted. If the scalp has been dissected, it will only be requisite to remove the calvarium at once; but if, on the other hand, the tegumentary tissue remains entire, and the object is merely to examine the pathological appearances of the contained organ, a different mode of proceeding must be pursued. An incision may be carried round the scalp above the ears, and the whole of the soft structures removed; or the crucial division may be adopted, turning down four flaps; but if cleanliness and avoidance of disfigurement are considered of importance, a transverse cut from ear to ear, the flaps being afterwards turned forwards and backwards, appears to be the most suitable. Having removed the scalp, the bone may now be fractured in a circular direction with the claws of a hammer; but this course is attended with very great disadvantage, in consequence of the irregular spicula resulting from the fracture being constantly liable to puncture the hands of the operator in the future examination of the membrane. We would therefore advise the use of the saw on all occasions; and although a little more tedious, the subsequent safety will amply compensate for the additional trouble. The bones should be sawed in a circular direction, half-an-inch above the superciliary arches, in front; the same distance above the occipital protuberances, behind; and laterally, on a level with the superior edge of the cartilage of the ear. Having sawn to a sufficient depth, a chisel may now be introduced into the groove anteriorly, forcing off the calvarium from before backwards, the attempt being attended with much greater facility in the adult, than in the very early and advanced periods of life; as in the one, intimate adhesion always exists, depending on the free vascular communication between the pericranium and dura mater; and in the other, the same difficulty is likewise encountered, produced by the ossification of the external layers of the latter membrane.

The student should observe the different degrees of thickness presented by the calvarium at its sawn margins; laterally, being thin and brittle, where the parietal and sqamous plates of the temporal bones enter into its formation, but thick and dense in its occipital portion; while anteriorly, it is remarkable for irregular cavities of variable size, resulting from the separation of the tables to form the frontal sinuses.

The dura mater, now exposed, and belonging to the class of fibrous tissues, is strong, dense, and of a bluish-white colour, the structure being distinctly fibrous in all situations. It covers and adheres to the whole internal surface of the bones, presenting two surfaces,—one external, rough, and fibrous, and the other internal, smooth, pol-

ished, and glistening; the latter character resulting from the parietal layer of arachnoid, which closely adheres to it. In many situations the dura mater can be divided into two layers, the external being adherent to the bone in all parts, and therefore acting as a periosteum; while the internal dips inwards to form the processes, as well as the walls of the sinuses. The membrane adheres most intimately to the lines of the sutures, but is still more closely connected to the bones constituting the vault of the skull, particularly to the petrous portion of the temporal bone, from which it is most difficult to remove it, even after maceration. It is also much stronger in the base of the skull than in the calvarium, but cannot be divided into layers in this situation, except in a few instances, which will be mentioned hereafter.

The uses of the dura mater are various, and may be thus enumerated:—firstly, to act as an internal periosteum; secondly, to separate and preserve the several divisions of the brain from mutual pressure; thirdly, to form sinuses; fourthly, to send processes out on the nerves to form their external fibrous sheaths; fifthly, to constitute, by its prolongation forwards, the periosteum of the orbit; and downwards, the theca vertebralis; and sixthly, in fœtal life to assist in the development of the bones.

The processes, which it forms are six in number—namely, 1. Falx cerebri; 2. Tentorium cerebelli; 3. Falx cerebelli; 4. Sphenoidal; 5. Orbital; and 6. Vertebral. The *sinuses*, are venous canals lying in the vicinity of the bone, and consist of a surrounding investment of dura mater, lined internally by a continuation of the serous venous tunic, derived from those veins with which they communicate. It is obvious, that the strong fibrous layer of dura mater which surrounds them prevents, during momentary congestion, that injurious pressure which might otherwise result to the brain, if yielding and expansile veins were substituted, for these fibro-venous canals. The sinuses are nineteen in number—namely, superior longitudinal, inferior longitudinal, straight, cavernous, circular, transverse sphenoidal, superior and inferior petrosal, transverse occipital, lateral, posterior occipital, and the torcular Herophili; these, with the processes, should now be examined in detail, but before doing so, it will be necessary to take a cursory glance at the superficial surface of the dura mater, with the several parts lying on it.

The surface now exposed, presents a rough fibrous aspect, owing to numerous processes that are prolonged into the bone, particularly at the sutures, these fibrous prolongations being the obliterated remains of vessels that connected the dura mater with the pericranium, in fœtal life. It is likewise observed to be dotted with blood, owing to the rupture of those vessels (principally veins),

which are still permeable on the sides, and the anterior posterior part; while ramifications of the anterior, middle, and posterior meningeal arteries are spread over the surface, to which they intimately adhere. Near to the median line, the glandulæ Pacchioni occur, these small bodies being granulated on the surface, and varying much in size, number, and shape, being either conical, flattened, or hemispherical; they are larger in old age than in middle life; but totally absent in the infant. They are generally of a light pink colour, but in very old subjects perfectly pale; they arise from the pia mater, on the surface of the brain; and carrying the arachnoid, which is pale and opaque, for some distance on their exterior, ultimately absorb it, as well as the dura mater, continuing to increase in size until they come in contact with the bone, which they likewise absorb, producing deep pits or hollows, in many cases even extending to the diploe. Bichat believed their origin to be connected with chronic inflammation of the membranes, and this opinion would appear to receive some confirmation, from the existence of opacity of the arachnoid in their vicinity. From the position which they occupy, they have been divided into three sets—an external, a middle, and internal; of these, the external, or osteal, set are the largest and most numerous, some being seen on the surface, whilst others are in the process of absorption, merely making their appearance through the membrane; the middle may occupy two situations—namely, either between the layers of the dura mater, or within the cavity of the superior longitudinal sinus, but separated from the blood by the venous lining; while the third, or most internal, are found on the surface of the brain, some free, and others connecting the visceral and parietal layers of arachnoid together. The use of these bodies is utterly unknown, although many and various theories have been proposed, to account for their existence.

The student's attention may now be directed to the middle line of the dura mater, where a longitudinal depression is observed, which corresponds to the longitudinal sinus, and this should now be examined, by opening it with a pair of scissors from before backwards; but as a certain system must be observed, we prefer in the first instance to proceed with the description of the processes, and in order to accomplish this object, it will now be necessary to divide the dura mater on one side, on a level with the sawn bone; when, by gently drawing aside the hemisphere of the brain, the *falx cerebri* will be exposed.

PROCESSES OF DURA MATER.

Falx Cerebri.—A sickle-shaped fold of dura mater, occupying the great longitudinal fissure between the hemispheres, which it

supports in the varied movements of the head. It presents for examination an apex and base; a convex and concave margin, and two surfaces. The apex, is attached anteriorly to the crista galli of the ethmoid bone, which it seems to embrace; and the base posteriorly to the upper surface of the tentorium, being broad and bifid, and slinging, so to speak, the tentorium in the midst, where it incloses the straight sinus. The convex margin is attached in the median line to the frontal, parietal, and occipital bones, where, by its bifurcation, it incloses the superior longitudinal sinus; while the concave edge is free, and corresponds to the upper surface of the corpus callosum posteriorly, from which however, it is separated by the arachnoid membrane uniting the two hemispheres, but is at some distance from it anteriorly, where it frequently presents a reticulated appearance.

Tentorium Cerebelli.—Forms a kind of platform between the cerebrum and cerebellum, and is somewhat semilunar in shape, presenting for description two margins, two surfaces, and an oval aperture in its anterior or free edge. The convex margin, thick and bifid, is attached to the crucial ridge of the occipital bone, and to the lips of the transverse sulcus of the same bone; to the posterior inferior angle of the parietal, to the mastoid, and petrous portions of the temporal; and lastly, to the posterior clinoid processes of the sphenoid. The concave margin free (except at its terminal points, which, sharp and prolonged, glide over those of the convex margin, to be attached to the anterior clinoid processes), thus circumscribes a semilunar aperture, bounded posteriorly and laterally by the tentorium, and anteriorly by the clivus basis cranii; into this opening the pons Varolii and superior vermiform process of the cerebellum project, whilst it also gives passage to the basilar artery and crura cerebri; in this manner the pons establishes a direct connexion between the elements of the mesocephalon, which unite the cerebrum, cerebellum, and the medulla oblongata; and by the transmission of the basilar artery, it also permits a free communication between it and the carotid, the two great sources of vascular supply to the central organ of the nervous system. The superior surface of the tentorium, convex, and directed downwards, backwards, and outwards on either side, is suspended in the middle by the falx cerebri, and supports the posterior lobes of the brain; while the inferior surface, concave, receives the attachment of the falx cerebelli near its posterior margin, and corresponds to the superior surface of the lobes of the cerebellum. Osseous plates are frequently found between the laminæ of this process, rudimentary of the normal structure in the feline species, and these, when examined microscopically, always exhibit the presence of Haversian canals, which we

have demonstrated in a plate taken from the tentorium, immediately over the fifth pair of nerves.

SPHENOIDAL FOLD OF DURA MATER.—Thick, rounded, and strong, but not very extensive; is a continuation outwards of the concave edge of the tentorium, along the posterior edge of the lesser wing of the sphenoid, to which it is almost inseparably connected. It increases the expanse of the anterior fossa of the base of the skull, and prevents the undue pressure of the anterior lobe on the sphenoidal lobule of the middle, as well as on the several nerves as they enter to supply the orbit through the lacerated orbital hole. It corresponds to the fissure of Sylvius at the base of the brain, but its ascent for any distance into this sulcus, is prevented by the arachnoid membrane, stretched tensely across from the anterior to the middle lobe, which also protects the middle cerebral artery from all undue pressure from the same fold.

FALX CEREBELLI.—To see this process, the tentorium must be raised, when it will be seen to be of a triangular form, with the base above, attached to the tentorium, and the apex inferiorly at the foramen magnum, where it often bifurcates, so as to surround the posterior half of that opening; the posterior edge, thick and bifid, is connected to the vertical spine on the occipital bone, inclosing the occipital sinuses, while the anterior lies in the incisura posterior of the cerebellum.

SINUSES OF THE BRAIN.

As these have already been enumerated, we will commence our description with the superior longitudinal, which is the longest and most important of all those peculiar fibrous structures.

SUPERIOR LONGITUDINAL SINUS, is a venous canal extending from the ethmoid to the occipital bone, situated in the convex margin of the falx cerebri, and corresponding to the mesial line of the frontal, parietal, and occipital bones; it is much larger posteriorly, than anteriorly; and a section shows its cavity to be triangular in figure, the base formed superiorly by the periosteal layer of the dura mater and the bone itself; and the sides by the internal laminæ dipping inwards to form the falx cerebri; it commences by a small vein passing upwards from the nose through the foramen cœcum, or sometimes by a *cul de sac;* and terminates either in the torcular Herophili, or in the right lateral sinus. When the cavity is laid open, the following parts are observed:—Chordæ Willisii, openings of the veins, and glandulæ Pacchioni. The chordæ Willisii, are white silvery bands which cross the sinus obliquely from side to side, and are more numerous posteriorly than anteriorly; the venous membrane is re-

flected around them, giving them a flattened appearance, and their use appears to be, for the purpose of preventing over-distention of the walls of the sinus. The veins opening into the sinus, are derived from the internal and superior surfaces of the cerebral hemispheres. The former, or internal hemispheric veins, from four to five in number, run upwards between the falx, and inner side of the hemisphere, and there unite with the superior branches; while the latter, or superior, about eight or ten in number, consist of three sets—an anterior, middle, and posterior; of these the anterior, and posterior wind, the one upwards, backward, and inwards; and the other upwards, forwards, and inwards, to reach the superior longitudinal sinus. The middle cerebral is, however, remarkable for its very large size; it commences in the fissure of Sylvius, runs at first upwards and backwards, then curves forwards, and with the other superior branches, proceeds from ten to twelve lines between the layers of the falx, in a forward direction, prior to opening into the sinus, which they enter in a direction from behind forwards, or contrary to the current of the blood, a course which is conceived to obviate the tendency to regurgitation; the anterior branches, however, constitute an exception to this rule, as many enter the sinus directly. Immediately at the venous openings into the sinus, an areolar structure may be seen; or, where this is absent the venous set of glandulæ Pacchioni is situated exactly at the orifices, where they are said to act as ball-valves, precluding regurgitation from the sinus into the veins. In addition to the cerebral, several venous branches also, from the dura mater and osseous diploe, pour their contents into the sinus; and in the majority of instances, a small vein passes through the posterior superior angle of the parietal bone, producing an indirect communication between the cerebral and general venous system.

Inferior Longitudinal Sinus, lies in the concave edge of the falx, occupying only, however, its two posterior thirds; it commences by a branch which, descending between the layers of the falx, connects it with the superior longitudinal, and then passes backwards in the concavity of that process, dividing ultimately into two posteriorly,—one, which opens into the commencement of the straight sinus; while the other, curves backwards, and terminates in the same sinus, about the middle of its course. Strictly speaking, it should be considered as a proper vein, as it possesses the two coats peculiar to that system of vessels; it is enveloped, however, by dura mater, and receives venous branches from the falx, but none from the brain.

Straight Sinus, lies between the base of the falx, and the upper surface of the tentorium; it is of a triangular shape anteriorly, but

rhomboid posteriorly, and its direction is obliquely downwards and backwards; anteriorly, it receives the inferior longitudinal sinus, with the venæ magnæ Galeni; whilst posteriorly, it communicates with the torcular Herophili; at its commencement it is sometimes double, and not unfrequently a few glandulæ Pacchioni are seen in this situation. We have never observed any cerebellar veins communicating directly with it in any point, and hence we are led to consider it merely as the continuation of the inferior longitudinal, and veins of Galen.

Posterior Occipital Sinuses, are exceedingly small, and lie between the layers of the falx cerebelli; they commence at the lower angle of the torcular Herophili, and at first pass vertically downwards; then, diverging behind the foramen magnum, they run forwards, to communicate with the lateral sinuses just at their termination; occasionally we have seen them joining the posterior condyloid vein, and still more rarely with cœcal extremities; they receive inferiorly, veins from the dura mater and bone, but rarely from any other source.

Torcular Herophili, implies the occipital confluence of the sinuses, and is well seen by removing a portion of bone about one inch square, including the occipital protuberance, from the back of the skull. Its figure is diamond-shaped, being formed by the common attachment of the falx cerebri, falx cerebelli, and tentorium; it exhibits six openings, on its internal aspect,—one superiorly, corresponding to the superior longitudinal sinus; two inferiorly, to the occipital; one at each lateral angle, to the lateral; and one anteriorly, to the straight. This reservoir is occasionally absent, and then the majority of the sinuses enumerated, open into the right lateral; when however, it does exist, it is always situated below, and to the right side of the point opposite to the occipital protuberance.

Lateral Sinuses, are symmetrical, or right and left; the former being the larger, and the latter the longer of the two. Each sinus commences from the lateral angle of the torcular Herophili, and passes at first horizontally outwards, grooving the occipital bone, and the posterior inferior angle of the parietal; then curves downwards, in the deep sulcus of the mastoid portion of the temporal; and lastly turns forwards and inwards, again indenting the occipital behind, where it pierces the dura mater stretched across the foramen lacerum posterius in basi cranii, and terminates in the jugular vein. In its posterior portion it is triangular, owing to its lying in the bifurcated edge of the tentorium, but in its anterior circular, in consequence of the depth of the bony groove in which it is contained, and being only covered by one layer of dura mater. The terminal point of this sinus, has the following relations:—Anteriorly, inferior

petrosal sinus; posteriorly, the transverse process of the occipital bone, which presents an excavation for its reception; externally, the jugular fossa in the petrous portion of the temporal bone; and internally, the eighth pair of nerves. The veins communicating with the lateral sinus are the following:—Lateral and inferior cerebral, which, commencing by branches on the sides and under surface of the posterior part of the cerebral hemispheres, unite into four or five trunks, and open from before backwards, into the horizontal portion of the sinus; also the inferior and lateral cerebellar veins, which, arising on the under surface of the lobes of the cerebellum, run towards its circumference, and uniting into three trunks, likewise open into the lower wall of the horizontal portion of the sinus; and lastly, it receives the mastoid vein, by which a communication is established between it and the occipital externally.

Cavernous Sinus, situated on the side of the body of the sphenoid bone, is prismatic in form, and consists partly of bone and partly of dura mater, with an internal venous lining. It is bounded externally, by the concave edge of the tentorium, expanding to line the middle cranial fossa; internally, by the side of the body of the sphenoid bone, covered by a periosteal layer of the same membrane; posteriorly, by the convex margin of the tentorium, attached to the posterior clinoid process; and anteriorly, by the foramen lacerum orbitale. This fibrous space contains, in its internal wall, the deep carotid artery, on the outer side of which, runs the sixth nerve; and in its external, the third, fourth, and ophthalmic division of the fifth; the venous sinus lies in the middle, receiving anteriorly the ophthalmic vein, and terminating posteriorly in the superior, and inferior, petrosal sinuses. It will however, be necessary to examine the fibrous walls of this space, as well as the parts connected with it, a little more in detail, in order to understand distinctly the mode of its formation, and we must therefore, again return to the anatomy of the tentorium. On tracing the concave edge of this process forwards, it glides, as we have already observed, over the posterior clinoid process, to be inserted into the anterior; presenting superiorly, a strong elevated margin, which splits into two layers; one weak and thin, passing inwards beneath the pituitary body, and assisting to form the circular, and sphenoidal sinuses; the other, stronger and thicker, being continued outwards to form the outer wall of the cavernous sinus. But as the convex margin of the tentorium dips inwards, to be connected with the posterior clinoid process, a decussation occurs between it and the concave margin, leaving between them a triangular space, in which the third nerve rests. The convex margin, or process, has not as yet however, assumed its final arrangement, for at the side of the sphenoid bone it splits into two layers, one of which sinks

between the internal carotid and the bone, and can be traced outwards beneath the Casserian ganglion; while the other, also passing outwards, forms the internal layer of the outer wall of the sinus, separating the nerves occupying this situation from the venous membrane, as well as forming a partition between the fossette for the Casserian ganglion, and the cavernous sinus. The venous membrane within this space is loosely attached, and constitutes anteriorly, a circular canal; posteriorly, becomes oval, where it joins the petrosal. In the former situation the sinus receives the ophthalmic vein, the proper fibrous coat of that vessel being prolonged for some distance on the sinus; but in the latter position it is destitute of any covering except the dura mater. On laying the cavity open, several fibrous bands are seen crossing in every direction, but most numerous posteriorly, with several small arterial branches running through them, producing an appearance something similar to that of the corpus cavernosum penis, and hence its name; the use of this structure undoubtedly being, to prevent regurgitation of the venous blood towards the eye, when the head is inclined downwards and forwards, as in reading.

CIRCULAR SINUS, lies in the sella turcica; and consists of an anterior, and a posterior crescentic portion; the former, lying in front and above; the latter, below and behind the pituitary body; and communicating on either side, with the cavernous sinus. A third sinus (TRANSVERSE SPHENOIDAL) is sometimes present, crossing the body of the sphenoid, and also communicating with the cavernous, on each side; we have however, frequently observed its absence. These sinuses receive veins from the bone, and the pituitary body, but not from the brain.

PETROSAL SINUSES, are two in number—one superior, and the other inferior, with a similar pair on the opposite side of the skull.

Superior Petrosal commences anteriorly, at the cavernous, and running backwards in a groove on the superior angle of the petrous portion of the temporal bone, between the layers of the tentorium, terminates in the lateral sinus. Its figure is triangular, and it receives veins from the superior and inferior surface of the cerebellum, and frequently a transverse branch from the velum. Immediately behind the point of the petrous portion, it is separated from the bone by the fifth pair of nerves; in one instance only, have we ever observed the complete absence of the entire sinus.

Inferior Petrosal, much larger, but only about half the length of the other, commences also at the cavernous, often in common with the *superior;* it passes downwards and backwards, corresponding to the junction of the petrous portion of the temporal bone with the cuneiform process of the occipital bone, and then piercing the dura

mater, which closes the foramen lacerum posterius, terminates in the internal jugular vein on the outer side of the eighth pair of nerves, receiving in its course the transverse occipital sinus, with a small diploic vein that passes through the foramen lacerum anterius. It is remarkable, because the dura mater does not intervene between the sinus and the cartilage uniting the occipital and temporal bones.

TRANSVERSE OCCIPITAL SINUS, small, and sometimes absent, lies on a level with the anterior lacerated opening, and crossing the basilar process of the occipital bone, communicates with the two inferior petrosal. Just at this point, a number of sinuses unite in confluence, namely, cavernous, petrosal, and transverse occipital—this dilatation being called the anterior torcular Herophili.

The SINUSES, placed within the skull, do not form a distinct system, as they communicate freely with the external veins, in several situations, which may be enumerated as follows:—The cavernous, with the ophthalmic vein; the superior longitudinal, with the vein that passes through the posterior superior angle of the parietal bone, as well as with those of the diploe, and nasoœcal vein; and the lateral, with the gulf of the internal jugular, and with the mastoid.

The ARTERIES supplying the dura mater consist of three sets—anterior, middle, and posterior meningeal. The first, are principally derived from the ethmoidal branches of the ophthalmic; the second or the middle meningeal (greater, and lesser), from the internal maxillary; but the latter, may also arise from the internal carotid, whilst that vessel is in its cavernous stage, or from the ascending pharyngeal, a small branch of which enters the foramen lacerum anterius in basi cranii; while the third set, consist of two branches on each side, namely, the occipito-meningeal, which enters the cranium through the jugular foramen, and the vertebro-meningeal passing into the cranium by the foramen magnum,—these vessels being derived from the trunks indicated by their names.

The NERVOUS SUPPLY of the DURA MATER is exceedingly obscure, but its source may be stated to be from the fourth frontal, and Casserian ganglion of the fifth pair.

ARACHNOID MEMBRANE.

Belongs to the class of serous tissues, being a shut sac, consisting of two portions: namely, a parietal, and a visceral layer; the parietal adhering most intimately to the internal surface of the dura mater, except in the situation of the sella turcica, where the pituitary body is interposed between them; and the visceral covering the surface of the brain, passing over its involutions, and binding the convolutions

to each other. Its deep surface, is connected to the pia mater, which lies immediately beneath it, by a fine areolar tissue; but certainly not by any distinct membrane, as supposed by Dr. Sharpey,—the subarachnoid fluid occupying this position being, in all probability, derived from the pia mater, as the deep surface of the arachnoid, being devoid of epithelial investment, would appear to be incapable of secreting it. On the summit of the brain, the membrane is fine and weak, but increases in density and thickness at its base, particularly in the situation of the *sub-arachnoid spaces.* These spaces are five in number, namely, a middle, two lateral, a posterior inferior, and a posterior superior. The MIDDLE, corresponds to that medullary space, which is of an hexagonal shape, bounded laterally by the middle lobes, in front by the anterior, and behind by the crura cerebri, and pons Varolii. From this, there are six openings or outlets—viz., anteriorly, the termination of the great longitudinal fissure, by which the anterior cerebral arteries escape; laterally, the fissure of Sylvius for the exit of the middle cerebral; posteriorly and laterally, a cleft or fissure opens into the inferior cornu of the lateral ventricle, by the anterior extremity of the great semilunar notch of Bichat, which lies between the inner edge of the middle lobe (lobule of the transverse fissure) on the outside, and the tractus opticus, and crus cerebri on the inside, through which the choroid plexus, and artery pass on each side, in order to reach the interior of the brain; and posteriorly, the median groove of the pons giving passage to the basilar artery, constitutes the sixth opening of communication; over this space the arachnoid membrane, thickened by a series of fibrous trabeculæ, is stretched, covering loosely the circle of Willis, and the parts contained in it, and forming the seat of meningeal tuberculosis, when that diseased condition exists.

LATERAL SUBARACHNOID SPACES, correspond to the fissure of Sylvius, where the arachnoid is stretched from the anterior to the middle lobes. They communicate internally, with the middle or great space.

POSTERIOR INFERIOR SUBARACHNOID SPACE, corresponds to the floor of the fourth ventricle; and is bounded anteriorly, by the posterior surface of the medulla oblongata; laterally, by the lobes of the cerebellum; and posteriorly, by the arachnoid stretched between them.

POSTERIOR SUPERIOR SUBARACHNOID SPACE, is merely the involution of the serous membrane around the veins of Galen, as they merge, and never contains any fluid.

These spaces, and indeed all that prolonged interval between the pia mater and the arachnoid, are occupied by the *subarachnoid* fluid, which serves to adapt the varying size of the brain to the cavity in

which it is contained; but the predominance of the fluid inferiorly, in the vicinity of the large vessels which supply the organ, would seem to imply an equalizing function, in reference to the cerebral circulation. In the description of the visceral portion of the arachnoid membrane, we have not as yet alluded to that involuted part particularly noticed by Bichat, and besides him by Monro. If the posterior part of the hemispheres is raised, immediately above the superior vermiform process of the cerebellum, the venæ Galeni are seen emerging, invested with a process of arachnoid, and in connexion with them we may frequently observe a circular aperture (foramen of Bichat); which, however, is not always present. Still we can scarcely admit that its absence, even if constant, should be considered sufficient evidence to negative the idea of the complete continuity of the whole arachnoid; and we are convinced, by our own numerous and repeated examinations of fœtal brains, that the perfect continuity of ventricular and external ararchnoid should be admitted as an established fact; nor is the analogy which has been traced between the foramen of Bichat and that of Winslow in the abdomen, the exaggerated effort of a too vivid an imagination, as some writers seem to think. Dr. Sharpey conceives that a distinct but fine serous layer, lining the subarachnoid spaces, may in this way reach the ventricles, and so pass down in a similar manner to line the subarachnoid space of the cord; but the absence of an epithelial layer on the deep surface of the arachnoid, is sufficient to render this view at least questionable. The impossibility of introducing fluids from the external surface into the ventricles, has been urged as an argument against the continuity of the two structures: but it should carry no weight whatever, as the same objection, and on the same grounds, might be advanced against the continuity of the peritonæum with the tunica vaginalis of the scrotum.

STRUCTURE.—The arachnoid consists of a surface layer of pavement epithelium, with a thin basement membrane, supported by a fine but lax areolar tissue. Its vascular supply is small, perhaps only amounting to nutritive imbibition, and even when inflamed it fails to exhibit any trace of vascularity, as it is only rendered opaque in that morbid condition. The use of this membrane appears to be to facilitate the almost imperceptible movements of the brain, synchronous with the circulatory, and respiratory rhythms.

PIA MATER.

An areolo-vascular membrane covering the surface of the brain, sinking into the involutions, which it lines; and also sending off *processes* into the interior of the brain. Those processes are seven in

number,—namely, the choroid plexuses of the lateral, third and fourth ventricles of each hemisphere ; and the velum interpositum ; all of which will be described as met with in the course of dissection. By its superficial surface, the pia mater is connected loosely to the arachnoid, but with many intervals existing between them ; for instance, at the subarachnoid spaces, where it corresponds to the involutions of the brain, at the inferior cornu of the lateral ventricles; and at the sulcus for the olfactory nerves. Its deep surface is connected to the cortical structure of the brain, by vessels which tear the cineritious substance, when an attempt is made to remove the membrane forcibly. The pia mater, the nutrient membrane of the brain, similar in this respect to the neurilemma of the nerves, possesses the advantage of allowing the vessels to break up to an extreme degree of tenuity prior to their entrance into the yielding medullary matter,—in this way, like the rete of Galen, and that of Hovius, tending to reduce the impulse of the circulating system, which otherwise might directly injure or exercise too stimulating an effect on the organ, so as to disarrange or otherwise impair its delicate functions.

THE BRAIN.

Many different modes are adopted for the examination of this central organ of the nervous system, each having its peculiar fitness, either in reference to the display of the formation of the organ, or to the relative position of the several parts which compose it. In prosecuting the former inquiry, the organ may be dissected from below upwards; and in the latter, from above downwards; but as the student cannot pursue with advantage the whole investigation on a single brain, we prefer the mode by which he becomes at first conversant with the number, size, position, and relations of the individual parts of which it is composed, before he proceeds with the examination of its more complicated anatomy, in reference to its development, and those physiological relations which the several parts bear to each other.

The great nervous mass, constituting the *encephalon*, has been divided into cerebrum, cerebellum, and medulla oblongata,—the first being the great brain, the second the lesser, and the third the primordial portion of the whole mass; all being united and bound together by the pons Varolii, that forms a kind of common link between them. At present, however, we intend to confine our observations to the great or proper brain ; leaving the other two, as subjects for future consideration.

Cerebrum.—Is of an ovoid shape, larger behind than before, con-

sisting on its upper surface of two hemispheres, each representing the figure of a quarter sphere, and separated from each other by the great longitudinal fissure. Externally, and superiorly, the surface, convex and irregular, is marked by alternate elevations and depressions, the former being called *convolutions* or gyri, and the latter, *involutions* or sulci. These convolutions are much diversified in shape and size, as well as in direction; but still there are a few, which generally present a uniform character in all cases, and to these we will refer, in the examination of the different surfaces of the brain. Those on the upper aspect, may be divided into frontal, occipital, and parietal—the first, varying from three to seven in number, and taking a direction from before backwards; the second, consisting of three, and running from without inwards; while the third, varying from five to eight, pursues an exceedingly tortuous course from before backwards; but all are equally separated by involutions, which, passing to variable depths, are lined by a double fold of the pia mater. The parts entering into the formation of a convolution may now be examined by slicing off a portion of the surface, when the arachnoid, and pia mater, will be found to form the most superficial covering; next in order, is seen the grey or cineritious matter, about a quarter of an inch in depth; internal to which, the white or fibrous structure is observed. The elevations constituting the convolutions are merely the result of a folding of the cerebral surface, for there is no absolute interruption of continuity; this can be proved on removing the arachnoid, when the irregularities may be effaced with facility, by the application of slight and gradual pressure from the interior of the brain, in a direction outwards: the surface will then become perfectly smooth, a similar condition being consequent on the internal chronic form of hydrocephalus, as remarked by Sir E. Home. The production of the convolutions has been accounted for in different ways; thus it has been supposed that the brain, growing from below upwards and outwards, meets with the opposing cranial bones, and the surface accordingly becomes folded, to accommodate itself to the small space within the calvarium; it has also been stated that the diverging fibres, being of different lengths, some are sufficiently long to reach the convolutions, while others, much shorter, extend only so far as the involutions; and lastly, it has been argued that the peripheral fibres, plaited on themselves, produce this peculiar appearance. It is probable that the convolutions are intended to increase the surface on which the vessels are primarily ramified; but it is still undecided, whether their size and number exercise any particular influence on the various psychical powers, as observed existing in different individuals. The internal surface of each hemisphere is flat, and separated from its fel-

low by the great longitudinal fissure, containing the falx cerebri, which in the majority of cases constitutes a septum between them; but in some few examples, the greater part of the falx has been observed to be deficient, and then the two hemispheres were in a great measure fused with each other. The longitudinal fissure passes completely through the cerebrum, before and behind; but in the middle the corpus callosum renders it imperfect; the latter body may be brought into view by gently drawing asunder the hemispheres, and with the fingers removing the arachnoid, which covers its upper surface. On the internal aspect of the hemisphere, a well-marked and persistent lobule is always observed, called the *callosal lobule* (Ourlet), or gyrus fornicatus, which, lying like an arch immediately above the corpus callosum, bends forwards and downwards to terminate on the inner surface of the anterior lobe, while behind, winding at first downwards and backwards, and then forwards, it is continued along the inferior surface of the brain to the inner edge of the middle lobe, where it bounds the anterior and inferior extremity of the transverse fissure of Bichat externally; so that the fissure of Sylvius is the only point of interruption in the continuity of this lobule; superiorly the margin of the ourlet is serrated, constituting the crest of Vicq d'Azy, while its inferior surface is separated from the corpus callosum, by the ventricle of the hemisphere, into which the handle of a scalpel can be readily passed.

The student may now reverse the brain, and proceed to the examination of the base, or inferior surface, which is somewhat irregular, and divided on each side of the mesial line into three lobes which are symmetrical, and named anterior, middle, and posterior.

Anterior Lobe, triangular in figure, with the base anteriorly and externally, and apex posteriorly and internally at the optic commissure; is bounded internally, by the anterior extremity of the great longitudinal fissure, which divides it from that of the opposite side; posteriorly by the fissure of Sylvius which separates it from the middle lobe; and externally, by the periphery of the brain. Its inferior surface, concave and irregular, rests on the orbital plates of the frontal, and lesser wings of the sphenoid bone, and presents a groove or sulcus in which is imbedded the olfactory nerve, a single convolution always existing between it and the longitudinal fissure.

The Middle Lobe, very convex inferiorly, is bounded behind, by a superficial depression which corresponds to the superior angle of the petrous portion of the temporal bone; in front, by the fissure of Sylvius; and internally, by the circle of Willis, and the parts it contains; and externally, by the periphery of the brain. On its internal margin, a convolution is always present, limiting the transverse fissure externally, and formed by the inferior termination of the

callosal lobule (Ourlet). The middle lobe is supported, when *in situ*, by the greater wing of the sphenoid bone, and upper surface of the petrous portion of the temporal.

POSTERIOR LOBE, triangular in shape, and very pointed posteriorly, concave on its inferior surface, and supported by the tentorium cerebelli; is bounded internally, by the posterior extremity of the great longitudinal fissure; anteriorly, by the depression for the edge of the petrous portion of the temporal bone; and externally, by the periphery of the brain. It is marked inferiorly, by numerous large and winding convolutions, which are all continuations of the lobule of the transverse fissure.

FISSURE OF SYLVIUS, takes a direction upwards, backwards, and outwards, passing to an indefinite extent between the anterior and middle lobes; and on carefully unravelling the surface of the former, where it rests on the latter, a second smaller fissure is observed passing vertically upwards, and circumscribing the island of Reil; within the larger fissure, are found the external root of the olfactory nerve, and middle cerebral artery, with the island of Reil itself, and external perforated plate; this last, however, not being altogether within it, but rather internal to it; the arachnoid membrane is tensely stretched over the fissure, so as to separate the parts within it, from the sphenoidal fold of dura mater.

In the middle line of the base of the brain, the following parts present themselves for examination, when the arachnoid is removed:—1. Longitudinal fissure; 2. Lamina cinerea; 3. Optic commissure; 4. Tuber cinereum, with the infundibulum leading down to the pituitary body; 5. Corpora albicantia; 6. Locus perforatus medius; 7. Crura cerebri; 8. Pons Varolii; 9. Medulla oblongata, resting in the inferior notch of the cerebellum; and lastly—10. Posterior extremity of the great longitudinal fissure. Here also, a vascular circle, or more properly an heptagonal vascular space, exists, known as the *circle of Willis;* bounded in front, by the anterior communicating, and anterior cerebral arteries; laterally, by the internal carotid, with the posterior communicating branch; and behind, by the basilar artery, with the posterior cerebral; several of the parts above enumerated, lie within this space, and from before backwards are as follows:—lamina cinerea, optic commissure, tuber cinereum, with the infundibulum, corpora albicantia, middle perforated plate, inner margins of the crura cerebri, and the origin of the third nerve (see VASCULAR SYSTEM). Each of those parts, should now be examined carefully.

LAMINA CINEREA.—A grey layer, continuous in front with the rostrum of the corpus callosum, and as it passes backwards above the optic commissure, becomes attached to the tuber cinereum behind;

superiorly, it is also continuous with the grey lining of the third ventricle, and is pierced by the descending pillars of the fornix, while the lateral perforated plates lie on either side of it.

Optic Commissure.—(See Anatomy of Nerves).

Tuber Cinereum.—A reddish grey body of a small size, and reniform in figure, convex anteriorly, and notched posteriorly; is attached above, to the grey floor of the third ventricle; in front, to the optic commissure; and below and behind, to the infundibulum, which lies in its notch or hylus. It consists principally of granular cells, many of which are yellowish in colour, and so soft in their consistence that they break down into a pultaceous mass, on the slightest pressure; we have also observed a cavity in its centre.

Infundibulum.—A grey tube surrounded by arachnoid, is large above, where it communicates with the floor of the third ventricle, but smaller inferiorly, where it is attached to the pituitary gland; within the tube, the arachnoid is continued downwards, as far as the superior third, where it terminates in a *cul de sac;* but some high authorities contend, that it is pervious, in its entire extent.

Pituitary Gland, or Body.—An oval body, about the size of a horse-bean, is situated in the sella turcica, above the dura mater, beneath the arachnoid, and surrounded by the circular sinus. It is divided into an anterior, and a posterior lobe: the former dense, and consisting of granular cells, imbedded in fibrous loculi; while the latter soft, with larger cells, and a smaller amount of fibrous tissue receives the pointed extremity of the infundibulum. This body, is much better developed in the lower orders of vertebrata than in man; and in them always contains a cavity, which is rarely present in the human subject. The interior of this gland is usually filled with a kind of yellow tubercular matter. It is also much larger at the middle of intra-uterine life, than at birth; and at the former period, a central ampulla exists, which communicates with the third ventricle. The use of this body is still unknown, some believing it to be a ganglion of the sympathetic (Budge); others, glandular, as Monro; but neither of these opinions is supported by any deductions drawn either from the examination of its structure, or from pathological facts.

Corpora Albicantia, vel Candicantia, are two small hemispherical bodies, lying in front of the middle perforated plate, and behind the tuber cinereum; they receive superiorly, the descending pillars of the fornix; and are separated from each other by a deep fissure, producing that symmetrical arrangement peculiar to man and the carnivora, as in other vertebrata, they form a single and undivided body; they are likewise connected to the crura cerebri, and to the middle perforated plate.

Middle Perforated Plate.—A triangular lamina of medullary substance; bonnded laterally, by the crura cerebri, to which it is attached; in front, by the corpora albicantia; and posteriorly, by the pons Varolii. Its superior snrface corresponds to the third ventricle; while the inferior gives origin to the third pair of nerves, and is marked by several openings, through which small arterial twigs enter the cavity of the third ventricle, to anastomose at the foramen commune anterins, with branches accompanying the velnm interpositnm, and those of the choroid plexns to that point.

Pons Varolii.—So called from the fact of its being stretched like a bridge of communication between the cerebrum, cerebellum, and the medulla oblongata. It is cuboid in figure, and accordingly presents six sides: a superior, an inferior, two lateral, with an anterior and a posterior; superiorly, it corresponds to the tubercnla qnadrigemina, pineal gland, and the iter a tertio ad quartum ventriculum; inferiorly, to the basilar process of the occipital bone, dura mater, sixth pair of nerves, the basilar, and snperior cerebellar arteries; laterally, to the crura cerebelli, with the origin of the fifth, and seventh pair of nerves; in front, to the crura cerebri, middle perforated plate, and the origin of the third pair of nerves; and behind, to the cavity of the fourth ventricle, and medulla oblongata. The superficial surface, consists of the transverse fibres derived from the crura cerebelli; whilst a deeper section displays those of the olivary, and of the pyramidal bodies, passing through the central light grey substance of the pons (corpus rhomboideum) in their course to the cerebral hemispheres; in the middle line, a few of the transverse fibres dip inwards, so as to form a septum, dividing the pons into two symmetrical portions,—an appearance well exhibited in a transverse section of this part.

Crura Cerebri, lie immediately in front of the pons Varolii, and are thick, round cords directed ontwards and forwards; they connect the pons with the cerebral hemispheres, and are small posteriorly, bnt much larger and flatter anteriorly; internally, they correspond to the middle perforated plate, with the origin of the third nerve; externally, to the inner edge of the middle lobe, choroid plexus, choroid artery, and the tractus opticus; inferiorly, to the posterior cerebral artery, posterior communicating, and the optic nerve; and superiorly, to the optic thalami, and third ventricle. On cutting into the centre, a mass of grey matter appears (locus niger), which separates the fibres of the pyramidal, from those of the olivary bodies; and where the crura emerge from the pons, some annular fibres snrround them; while at their cerebral extremity, they run directly into the optic thalami, and corpora striata.

The student may now proceed to the examination of the interior

of the brain, and this should be done by cutting off one hemisphere a little above the level of the corpus callosum, when the centrum ovale minus of Vicq d'Azyr will be exposed. This consists of a central mass of white or fibrous structure, surrounded by a wavy line of cineritious or grey matter, and interspersed with some scattered red points, indicating the extremities of vessels divided by the incision. When both hemispheres have been removed on a level with the corpus callosum, the whole surface represents the centrum ovale majus of Vieussens, the corpus callosum now assisting in completing the white or fibrous substance in the centre.

Corpus Callosum, or Commissura Magna Cerebri, consists of a white strong layer of transverse fibres, uniting the hemispheres of opposite sides. It is from three to four inches in length, an inch and a half in breadth posteriorly, but not more than three-quarters of an inch anteriorly, situated nearer the anterior than the posterior part of the brain, and presents for description two surfaces, two margins, with an anterior and a posterior extremity. The superior surface, convex from before backwards, corresponds to the hemispheres, from which it is separated by the hemispheric ventricle, to the callosal arteries, and the arachnoid membrane, which separates it from the concave margin of the falx cerebri; while on it, are seen the following parts:—Directly in the median line, and running from before backwards, a depression (raphe), indicating the union of the opposite sides of the brain; and on either side of it two white longitudinal filaments (longitudinal nerves of Lancisi), not unfrequently absent, and about a quarter of an inch external to these, the grooves for the callosal arteries; while occupying the whole extent of this surface, and running from without inwards, or from the hemisphere to the raphe, is a continued series of transverse fibres (lineæ transversæ Willisii). The inferior surface, concave, corresponds in the mesial line, anteriorly, to the septum lucidum; but more posteriorly, to the fornix, with which it appears to be blended on either side, and to the anterior cornu, and body, of the lateral ventricle; the margins receive the converging fibres of the hemispheres, which, in fact, form the principal part of this body, and unite with each other, as already observed, to constitute the mesial raphe. The anterior extremity, curved downwards, nearly at a right angle, constitutes a process called the genu, and then passing backwards, almost horizontally, forms another, termed the rostrum; it now divides into a middle, and two lateral bands; the former, passing almost horizontally backwards, above the anterior communicating artery, and optic commissure, with which it is intimately connected, becomes continuous with the grey floor (lamina cinerea) of the third ventricle, and tuber cinereum; while the latter, curving also downwards, backwards, and out-

wards, on the external side of the tractus opticus, terminate on each side at the point where the transverse and Sylvian fissures unite, where they constitute the *callosal pedicles*, and form the lateral boundaries of the lamina cinerea. The posterior extremity (splenium) of the corpus callosum, which is blended with that of the fornix, and beneath which it winds to form the Lyra, or corpus Psalloides, is thick, round, and cushion-like (Bourelet), corresponding to the superior vermiform process of the cerebellum, from which it is separated by the transverse fissure, containing the velum interpositum and the venæ Galeni. In the middle line of the posterior edge, the raphe is deeply fissured, and this appearance has been erroneously attributed to the pulsations of the brain tilting it against the falx cerebri; on either side, its fibres can be traced into the posterior and inferior cornua of the lateral ventricles, where they expand to give a white investment to the hippocampus major, and minor; or according to some, it actually takes an origin from them.

The student should now proceed to the examination of the *cerebral ventricles*, which are five in number, namely, two lateral, the third, fourth, and fifth. The *lateral* ventricles are symmetrical, being one for each hemisphere; but the *third*, the *fourth*, and the *fifth*, being situate in the middle line of the brain, are asymmetrical.

Lateral Ventricles, may be opened by making a superficial incision through the corpus callosum, on one side of the raphe, when by turning the medullary structure outwards, and following the cavity in a direction outwards and forwards anteriorly, and backwards and inwards posteriorly, the interior of the horizontal portion of the cavity will be exposed; a similar dissection may also be made on the opposite side; and lastly, by placing the knife at the posterior extremity of the optic thalamus, and carrying an incision downwards and forwards towards the fissure of Sylvius, the deeper or vertical part will be brought into view. Each lateral ventricle is curved, like an italic *S*, converging, as a whole, anteriorly, and diverging posteriorly; their extreme points, however, taking precisely opposite directions as they diverge in front, and converge behind: while each is divided into an anterior, and, posterior cornu, with an intervening body, and also an inferior, or middle cornu.

Anterior Cornu, triangular in shape, with the base behind, and apex in front, is bounded superiorly, externally, and internally, by the corpus callosum; and inferiorly, by the larger extremity of the corpus striatum.

The Body, oblong in figure, is bounded superiorly and externally by the corpus callosum, and internally by the septum lucidum; while the floor is formed from without, inwards and backwards, by the tail

or lesser extremity of the corpus striatum, by the tænia semicircularis, optic thalamus, choroid plexus, and fornix.

The *Posterior Cornu*, also triangular in outline, with the apex posteriorly and base anteriorly, is bounded superiorly, externally, and internally, by the medullary substance; and inferiorly, by the hippocampus minor, and the digital fossa.

The *Inferior Cornu*, incurvated in its direction, passing at first outwards and backwards, then downwards, forwards, and inwards, towards the internal extremity of the fissure of Sylvius, is bounded externally by the medullary structure; internally, by arachnoid membrane; above, by the tail of the corpus striatum, tænia semicircularis, and posterior part of the optic thalamus; and inferiorly, by the hippocampus major, pes hippocampi, tænia hippocampi, fascia dentata, and choroid plexus.

Septum Lucidum.—In order to obtain a good view of this structure, the narrow slip of the corpus callosum, which still remains, should be pressed to one side, when it will be seen to be a thin lamina of grey and white medullary structure, triangular in shape, with the base anteriorly and apex posteriorly, forming a vertical partition between the bodies of the lateral ventricles; and attached superiorly and anteriorly, to the corpus callosum; and posteriorly and inferiorly, to the fornix, and anterior commissure. In order to see the cavity of the fifth ventricle, which is situated in its midst, the corpus callosum should be cut across in the middle, and one portion reflected backwards, and the other forwards, when the laceration of the part will expose anteriorly the fifth ventricle, which generally is nothing more than a mere fissure or chink, between the layers of the septum lucidum, the layer on each side being composed of the four following laminæ; namely, most externally, arachnoid, a portion of the serous lining of the lateral ventricle; to which succeeds a grey, and then a white layer; and lastly, arachnoid again, lining the cavity of the fifth ventricle itself. The serous lining of this ventricle constitutes a closed sac in the adult, but in the fœtus is connected, by the canal of Wenzel, with the foramen commune anterius, and thus with the cavity of the general arachnoid; but this communication disappears early in life, although in some exceptional cases of chronic internal hydrocephalus it may occasionally be present, with margins distinct and well defined. The walls of the cavity, are usually thin and diaphanous; but we have frequently seen them, fully one-eighth of an inch in thickness.

Fornix.—By now removing the septum lucidum, the fornix is brought into view, consisting of a triangular lamina of white medullary structure, with the base behind and the apex in front. It arises posteriorly, by three bands on each side,—one from the

tænia hippocampi, the second from the hippocampus major, and the third from the hippocampus minor; these unite, and, form a flat band (posterior pillars), which coalesces with that of the opposite side to form the body of the fornix, which, extending as far forwards as the foramen of Monro, there dips downwards and backwards, and divides into the two descending pillars, which pierce the grey floor of the third ventricle, and terminate within the circle of Willis in the corpora albicantia. The fornix consists of longitudinal fibres, that occasionally exhibit a median splitting into two symmetrical halves; and on this account the name of twain-band has sometimes been applied to it. The upper surface corresponds to the corpus callosum, and septum lucidum; the inferior lies on the velum interpositum, and the foramen commune anterius; while its margins are bounded on either side by the choroid plexuses.

By now dividing it transversely, and reflecting its anterior and posterior portions, in the former segment its *pillars* can be seen descending as round white cords behind the anterior commissure, and in front of the foramen commune anterius, receiving in their course these reinforcing structures:—The horizontal peduncles of the pineal gland; and tænia semicircularis of each side, which join them in the foramen commune anterius; and while running on the inner side of the optic thalami they also receive some fibres from those bodies; lastly, they acquire also some additional tissue from the grey floor of the third ventricle. On the posterior part of the fornix, and on its under surface, a peculiar arrangement called lyra, or corpus psalloides, may be observed, consisting of the transverse fibres of the posterior extremity of the corpus callosum, which curve beneath it, and appear between its converging roots.

Velum Interpositum, consists of a double fold of pia mater, which enters through the transverse fissure of Bichat, at the posterior part of the brain, below the corpus callosum, and fornix; and above the superior vermiform process of the cerebellum, and the tubercula quadrigemina. This fissure, merely the transverse portion of the great semilunar notch, can be traced downwards and forwards on each side, to terminate at the base of the brain, between the crura cerebri, and the middle lobes, behind and internal to the fissure of Sylvius. The velum interpositum enters the brain through its horizontal portion, and the choroid plexuses through its anterior extremity; from thence the latter proceed into the inferior cornua of the lateral ventricles, and from thence into the body, to join the velum interpositum, and the foramen commune anterius. The velum interpositum is triangular in shape, with the apex in front and base behind, and encloses between its folds the venæ Galeni and arachnoid canal, but the pineal gland is certainly not between its layers.

as generally stated, but beneath both. The velum interpositum lies immediately beneath the fornix, and rests on certain parts which will be again noticed, when the relative anatomy of the several bodies in the mesial line of the lateral ventricles will be examined.

Corpus Striatum.—Pyriform in shape, with the larger extremity directed forwards and inwards, and the smaller upwards, backwards, and outwards; is grey on its external surface, but both white and grey within, and hence its name. It corresponds above, to the floor of the anterior cornu, and body of the lateral ventricle; below, to the fissure of Sylvius, the island of Reil, and inferior cornu of lateral ventricle; externally, to a white medullary capsule, and the substance of the hemisphere; and internally, to the anterior commissure, septum lucidum, sides of the foramen commune anterius, tænia semicircularis, and optic thalamus. If a section is made longitudinally into its substance, an horizontal layer of white fibres will be observed passing into it from the crura cerebri, and again radiating outwards from it, to reach the hemisphere, appearing to divide this body into an upper, or ventricular, and an inferior, or extra-ventricular portion; while additional white fibres, derived from the anterior commissure, likewise permeate its anterior part. It is usually known as a ganglion of reinforcement, and is one of the most vascular bodies in the brain, being frequently the seat of apoplectic clots, as well as of both acute, and chronic ramollissement.

Tænia Semicircularis.—A flattened band of medullary substance, lying between the corpus striatum, and the optic thalamus; arises from the corpus geniculatum externum on the posterior part of the optic thalamus, winds at first upwards, then downwards, forwards, and inwards, to join the descending pillars of the fornix in the foramen commune anterius. Of a yellowish white colour, it adheres intimately to the two bodies between which it runs, and near its anterior part is much thickened, a condition depending on the density of its arachnoid covering in this situation (lamina cornea); the vein of the corpus striatum passing beneath it at this point, often gives it a bluish tint. The tænia constitutes one of the commissures, uniting parts on one side of the middle line; for example, the fornix and optic thalamus.

Optic Thalami.—Symmetrical ovoid bodies, placed between the posterior divergent, or pointed, extremities of the corpora striata, are brownish grey in colour; each corresponding above, to the body of the lateral ventricle, choroid plexus, fornix, and velum interpositum; inferiorly, in its two posterior thirds, to the inferior cornu of the lateral ventricle, and in its anterior to the crus cerebri; externally, to the corpus striatum, and tænia semicircularis, and more

deeply, to a mass of white substance (double semicircular centre), which forms a septum between it and the corpus striatum; and internally, from before backwards to the descending pillars of the fornix, choroid plexus, peduncles of the pineal gland, commissura mollis, third ventricle, crura cerebri, posterior commissure, and the vertical peduncles of the pineal gland; the posterior extremities are notched, and divided into two tubercles,—corpora geniculata externa and interna,—the former giving origin to one root of the optic nerve, with the tænia semicircularis, and the latter to the second root of that nerve, where it lies in contact with the nates; the anterior extremities are smaller than the posterior, and correspond to the foramen commune anterius. The optic thalami are principally composed of grey matter, with a thin white coating, and through it the white fibres of the crura pass to the cerebral hemispheres, as well as to the posterior commissure, which connects them posteriorly and internally. This is another ganglion of reinforcement.

Choroid Plexuses, also symmetrical, are each composed of a fold of pia mater, entering the brain through the anterior extremity of the great semilunar notch, between the inner edge of the middle lobe (lobule of the transverse fissure) externally, and the crus cerebri and tractus opticus internally; it then passes upwards and backwards through the inferior cornu of the lateral ventricle, having the optic thalamus above it; and the tænia hippocampi and hippocampus major below it, until it reaches the posterior extremity of the optic thalamus, around which it winds, when turning forwards and inwards, it gains its superior aspect, lying in the body of the lateral ventricle, on the outer margin of the fornix, beneath which it dips to terminate at the foramen commune anterius, by joining the velum, with which however, it had become continuous for some distance previously. The choroid plexus contains, in its outer margin, the choroid branch of the internal carotid artery; and the vein of the corpus striatum runs beneath it, in its course to reach the venæ Galeni. In structure, it consists of the lining membrane of the ventricles, including a fold of pia mater, in which are very often seen small cells, sometimes so numerous, as almost wholly to obscure the vascular structure of the part.

Hippocampus Minor.—Known also as the unguis, or ergot lobule; lies on the inner and inferior part of the posterior cornu of the lateral ventricle, and is merely an involuted convolution of the brain; it is white on its surface, within which is contained a large mass of grey matter; while in shape it resembles a half crescent, convex outwards and forwards, large and rounded posteriorly, but small and pointed in front, where it is continuous with the fornix. Immediately on its outer side, a deep triangular fossette is found, called the digital

fossa, bounded internally, by the hippocampus minor; anteriorly, by the hippocampus major; and externally, by the medullary substance; this space is subject to much variation as to size, and is sometimes altogether absent.

Hippocampus Major, situated in the inferior cornu of the lateral ventricle, is a conoidal eminence, curved on itself, with its larger extremity turned downwards and forwards; this portion may be either bulbous, or divided by a notch into two tubercles (pes hippocampi), while a third, or smaller one, is frequently present above the others (pes accessorius). Its smaller extremity, directed at first upwards and backwards, and then curved forwards, is continuous with the fornix; while its concave surface, looking forwards and inwards, is bordered by the tænia, or corpus fimbriatum. It consists of an external white capsule, derived from the corpus callosum, with an internal mass of grey matter, and resembles the hippocampus minor in being an involuted convolution of the brain. It is the *Cornu Ammonis* of the older anatomists.

Tænia Hippocampi, or Corpus Fimbriatum, seen by raising the choroid plexus, which usually conceals it, is a small, flat, white band, which lies in the concavity of the hippocampus major, to which it is attached by its convex edge; it arises below, from the pes, and then passing upwards and backwards, terminates in the posterior root of the fornix. The concave border of the tænia is free, and presents a fringed appearance.

Fascia Dentata, exposed by raising the inner margin of the tænia, is immediately connected with the inner edge of the hippocampus major, and consists of a linear band of grey substance, indented or crenated at the margins, whence its name.

The student should now recur to the examination of the velum interpositum, the superficial relative anatomy of which has already been described; he should first direct his attention to the parts between the layers, the venæ Galeni, and the arachnoid canal.

Venæ Galeni, are formed by the union of the choroid and striate veins; the former commencing posteriorly, and having received the veins from the two hippocampi, runs forwards to meet the latter, which also commences posteriorly, and then courses forwards in the groove between the corpus striatum and optic thalamus, and under the tænia semicircularis; at the foramen commune anterius both unite, to form the venæ Galeni, and these having been further reinforced by a vein from the fifth ventricle, emerge from within the brain, by the transverse fissure, and open into the straight sinus.

Choroid Plexuses of the Third Ventricle, are two small granulated folds of pia mater, that pass forwards on the upper surface of the optic thalami, but united by their margins with those of the

lateral ventricles, and so descend into the cavity of the third; they are however, frequently absent altogether.

By now dividing the venæ Galeni, at the foramen commune anterius, and cautiously throwing the velum upwards and backwards, the following parts are brought into view from before backwards, and may be examined individually:—Anterior commissure, descending pillars of the fornix, foramen commune anterius, commissura mollis covering the third ventricle, foramen commune posterius, posterior commmissure, transverse band of the pineal gland, with its peduncles, pineal gland resting on the tubercula quadrigemina, valve of Vieussens, origin of the fourth nerve, processus a cerebello ad testes, and lastly, the superior vermiform process of the cerebellum.

Anterior Commissure.—A thick, white, round cord of white medullary tissue, stretched between the anterior and internal parts of the corpora striata; in this cord, their fibres radiate, in their course to the cerebral hemispheres, where some believe them to be continuous with the external roots of the olfactory nerves, at the fissure of Sylvius. As it runs across it is not perfectly straight, but slightly curved, with the concavity directed backwards, receiving the descending pillars of the fornix, which lean against it; in front, it corresponds to the rostrum of the corpus callosum; above, to the septum lucidum; and below, to the lamina cinerea.

Foramen Commune Anterius Monroi.—This aperture, first described by the anatomist whose name it bears, is bounded anteriorly by the pillars of the fornix, and the anterior commissure; posteriorly, by the optic thalami, choroid plexuses, and velum; laterally, it communicates with the lateral ventricles; below, with the third; and in the fœtus, also with the fifth, by the canal of Wenzel; into all those cavities it transmits the arachnoid lining, according to its discoverer, who thus proceeds to trace the course which it pursues.

Arachnoid Canal.—Formed by an involution of the external serous membrane, enters the brain through the foramen of Bichat lying below the velum (we believe, between its layers), and on reaching the foramen commune anterius, expands to line the lateral ventricles; descends through the same opening to line the third; passes forwards, through the canal of Wenzel, to line the fifth; and backwards, through the iter a tertio ad quartum ventriculum, to line the fourth; thus establishing a perfect continuity between the five cavities. This membrane is thin and fine, consisting of a surface layer of pavement epithelium, ciliated according to Henle, but simple according to Hassal, beneath which is a basement membrane, but the areolar tissue which in other situations is subjacent is here imperceptible.

Commissura Mollis vel Media.—A transverse lamina of grey

neurine, uniting the inner and upper margins of the optic thalami; it corresponds above, to the velum, and peduncles of the pineal gland; below, to the third ventricle; and anteriorly and posteriorly, to the anterior and posterior common holes. On tearing through its soft structure, the third ventricle is exposed.

THIRD VENTRICLE, consists of a chink or fissure between the optic thalami, but deeper and wider in front, than behind; bounded laterally, by the optic thalami, and in the inferior half, by the crura cerebri, which are here lined by a layer of grey matter; anteriorly, by the descending pillars of the fornix, and the anterior commissure; posteriorly, by the foramen commune posterius, posterior commissure, pineal gland, and tubercula quadrigemina; superiorly, by the commissura mollis, velum, and fornix; and inferiorly, by the lamina cinerea, optic commissure, tuber cinereum, corpora albicantia, middle perforated plate, and origin of the third nerves, or in other words, the parts from before backwards, in the circle of Willis. There are three, sometimes four, openings communicating with this ventricle—viz. superiorly and anteriorly, the foramen commune anterius, inferiorly, the infundibulum; and posteriorly, the aqueduct of Sylvius, with occasionally the foramen commune posterius, when it is pervious by the first, the arachnoid enters the cavity at its upper and anterior part; by the second, which commences at the central part of the floor, a connexion is established between the ventricle and the pituitary body; and by the third, which commences superiorly and posteriorly, the arachnoid passes to the fourth ventricle.

FORAMEN COMMUNE POSTERIUS.—Oval in shape, lyiug behind the soft commissure, and in front of the posterior, and bounded on each side by the horizontal peduncles of the pineal gland; it is usually cæcal, but occasionally we have seen it giving passage to a few arterial twigs, as well as to a slip from the choroid plexus, which become united with that of the third ventricle.

POSTERIOR COMMISSURE.—A thin, round, white band, smaller than the anterior, connecting the inner and posterior parts of the optic thalami; bounded above, by the pineal peduncles; behind, by the anterior edge of the tubercula quadrigemina; in front, by the foramen commune posterius; and below, by the aqueduct of Sylvius.

PINEAL GLAND.—Triangular or heart-shaped, with its base in front, called the *acervulus,* from containing some small earthy deposits, and apex behind, termed the *conarium;* when *in situ* it lies between the layers of the velum interpositum, according to some authorities, but according to others is invested in a process of its deeper layer, which is involuted around it, but is at the same time above it; it is connected to the brain by its four peduncles, and is supported by the tubercula quadrigemina. It is sometimes per-

fectly flat, and varies much in shape, size, and density. In colour it is of a light grey, and consists of vesicular matter, the cells being granular and caudate, and containing in the centre calcareous bodies of a stony hardness and rounded form, the larger being visible to the naked eye; but when viewed with a half or quarter-inch object-glass they bear much resemblance to masses of fat, each being composed of numerous, distinct, or aggregate lesser pieces or particles, which reflect the light strongly; and it is in this circumstance, as well as in their large size, that the resemblance borne by these bodies to masses of fat consists. In the natural condition these bodies are hard and brittle, but after the application of dilute nitric acid, they become soft, owing to the earthy matter of which they are composed, being dissolved away. If, however, the acid employed be somewhat stronger, these bodies undergo a singular change in form and appearance: the cellated spaces become almost lost to view, and these compound structures then assume the characters of large spherical cells, exhibiting numerous concentric lamellæ. When the earthy matter contained in these cells, or cellated spaces, is thus softened and dissolved away, by the application of the acid, the entire body becomes so soft as to admit readily of being torn to pieces with needles; and in this state its structure can be easily determined, and is seen to consist of membranous elastic tissue.

These bodies originate in exceedingly small and bright circular discs, which, when seen with the power we have indicated, are less in size than the head of a pin; and in this appears, first one, and afterwards other divisions, showing the compound or cellular character, which they ultimately more completely exhibit. The earthy matter entering into their composition consists of phosphate of lime, a small portion of phosphate of magnesia, and a trace of carbonate of lime. These bodies, which are almost peculiar to the human subject, are stated not to occur in the pineal gland until after the age of seven years (*Hassal's Microscopic Anatomy*, p. 535). We have, however, observed similar structures, not only in the choroid plexus, but likewise in the velum interpositum, but invariably in very old subjects.

Peduncles (Habenæ) of the Pineal Gland are four in number, two horizontal, and two vertical; the former are connected posteriorly with a transverse band attached to the front of the gland, and lying above the posterior commissure; from this point they pass forwards, diverging from each other, above the inner margins of the optic thalami, and join the descending pillars of the fornix, in the foramen commune anterius; the latter, or vertical, peduncles can only be seen by making a longitudinal vertical section of the brain, when they may be observed to arise from the under surface of the gland, from

which they pass downwards, on the inner and posterior part of the optic thalami, to be lost on the back part of the floor of the third ventricle, where it may be presumed they become continuous with the crura cerebri.

Descartes believed the pineal gland to be the seat of the soul, and Magendie conceived the equally absurd opinion, that it acted as a plug to the iter a tertio ad quartum ventriculum. It has however, always occurred to us, that it is the true superior commencement of the sympathetic system, holding, in fact, the same relation to this nervous chain above, that the ganglion impar does below.

TUBERCULA QUADRIGEMINA.—A quadrilateral plate of medullary structure, lying on the superior surface of the pons Varolii; covered by the velum interpositum, and pineal gland; and corresponding behind, to the valve of Vieussens, and the processus a cerebello ad testes, while it is related anteriorly, to the third ventricle, and posterior commissure. Its superior surface is divided by an antero-posterior fissure, as well as by a transverse; the latter being semilunar, with the concavity directed forwards, thus producing four bodies, called the tubercula quadragemina, the two anterior, which are also superior, being termed the *nates;* and two posterior, which are likewise inferior, being known as the *testes:* the former, are rounded, and grey in colour, with their long measurement directed obliquely outwards and forwards; while the latter are much smaller, and usually whiter and more oval in figure; the optic nerves are connected to the nates, and not unfrequently also to the testes, and hence they have been regarded as the ganglia of those nerves.

AQUEDUCT OF SYLVIUS, or, ITER A TERTIO AD QUARTUM VENTRICULUM.—If a probe is introduced beneath the posterior commissure and tubercula quadrigemina, and afterwards through the upper part of the pons Varolii, it will enter the fourth ventricle, at its superior and anterior part, through a canal directed obliquely downwards and backwards, along which the arachnoid membrane passes from the third, to line the cavity of the fourth ventricle.

FOURTH VENTRICLE, or, VENTRICLE OF THE CEREBELLUM.—This cavity is bounded above, by the valve of Vieussens, and the superior vermiform process of the cerebellum; inferiorly and anteriorly, by the posterior surface of the medulla oblongata, and calamus scriptorius; inferiorly and posteriorly, by the arachnoid membrane stretched from the medulla to the cerebellum; anteriorly, by the pons Varolii and iter a tertio ad quartum ventriculum; posteriorly, by the cerebellum; and laterally, by the processus a cerebello ad testes. In figure it is pentagonal, and we will now proceed to examine each of its walls in detail.

VALVE of VIEUSSENS, a lamina of grey neurine, thin and semi-

transparent, called by Haller the velum interjectum, is triangular in figure, with the base below and behind, attached to the middle lobe of the cerebellum; and the apex above and in front, connected to the testes; while its margins are united to the superior cerebellar peduncles (processus a cerebello ad testes). Its superior posterior surface concave, is covered by the superior vermiform process, and presents a notch behind, where it is connected to the linguetta; but anteriorly, a few grey transverse fibres are seen, from which arise the fourth pair of nerves, while in its centre, and running from before backwards, a grey elevated line may sometimes be observed, which is called the columella. The inferior anterior surface is somewhat convex, forms the roof of the fourth ventricle, and bounds the aqueduct of Sylvius above. Vieussens believed that this lamina acted as a valve to the aqueduct of Sylvius, but this is obviously an error, as it is only when a transverse section is made near the anterior part of the superior cerebellar peduncles, and the part consequently becomes depressed, that any such appearance exists.

Calamus Scriptorius.—For a description of the mode in which this is produced, see Medulla Oblongata.

Processus a Cerebello ad Testes.—For a description of those bodies, see Cerebellum.

Choroid Plexuses.—The choroid plexuses of the fourth ventricle are two in number, or one on each side; they commence by a very slender stalk, which is connected to the inferior vermiform process, wind round the medulla oblongata, behind the origin of the pneumogastric nerves, and becoming more expanded, terminate on the subpeduncular lobules.

THE CEREBELLUM.

The Cerebellum stands in a ratio to the brain as one to seven, and lies in the inferior occipital fossæ, immediately beneath the tentorium. It is somewhat heart-shaped, and divided into three lobes, two lateral and a middle; the superior surface, being rather obliquely sloped from the middle line downwards and outwards; while the inferior, is broad and very convex posteriorly, but comparatively narrow and pointed anteriorly. A horizontal sulcus surrounds the margin, separating the superior from the inferior surface, and terminating in front in a wide excavation (incisura anterior), which receives the medulla oblongata; and posteriorly, in a fissure which is occupied by the falx cerebri (incisura posterior). On its upper aspect anteriorly, the cerebellum presents a median elevation, more prominent in front than behind, known as the superior vermiform process, which overlaps in front the valve of Vieussens; it is divided by transverse sulci into three lobules, the anterior of which projects into

the incisura anterior, and is named the middle lobule; behind this is the second, or monticulus; and again, more posteriorly, a third, but smaller lobule exists, called the commissura simplex, which is gradually lost posteriorly in the median raphe. Inferiorly in the mesial line, we observe a sulcus, across which the arachnoid membrane is stretched, and when this is removed, the inferior vermiform process is exposed, transversely rugated like a silkworm, and divided into four portions:—most anteriorly, the nodulus, a pointed lobule, projecting into the fourth ventricle; immediately behind this, a grey elongated mass, named the uvula; still more posteriorly, a small blunted elevation representing the pyramid; and lastly, at the most posterior part of the inferior sulcus, or valley of Haller, is the commissura brevis. From each side of the uvula, two semilunar, flat, greyish white plates pass to the lateral lobes of the cerebellum, where they are overlapped by the tonsillitic lobules; the anterior margin of each is lunated and free, and the semilunar fossette between them, and the nodule on each side, is called the nidus hirundinis, or swallow's nest; while both taken together constitute the inferior medullary velum, the superior being formed by the valve of Vieussens. The surface of the cerebellum is divided into numerous concentric laminæ, grey externally and white internally, which are separated from each other by sulci, having their concavities all directed forwards and inwards, and by their aggregation forming lobules; those on the upper surface being two, namely, the anterior superior or lobulus quadratus, and the posterior inferior or lobulus semilunaris, the latter being the larger of the two. On the lower aspect, five lobules are present, namely,—the semilunar, which is near the posterior and lateral margin, and which is therefore circumferential; secondly, the slender or gracilis; thirdly, the digastric, which is bifid externally; fourthly, the amygdaloid or tonsillitic, projecting internally into the valley of Haller, and producing that peculiar arrangement of parts similar to those at the posterior portion of the mouth, there being in the vallicula, tonsils situated laterally, uvula in the middle, and the inferior medullary velum, similar to the soft palate, uniting them; the fifth lobule, the pneumogastric or subpeduncular flocculus, is connected to the crura cerebelli by two stalk-like processes, and lies behind the eighth, and below the seventh nerve. In connexion with the cerebellum, the isthmus encephali, or nodus cerebri, ought to be examined: it is a narrow medullary mass, occupying the space between the cerebrum, the cerebellum, and the medulla oblongata, and should be regarded as a compound body, being made up of the following parts:—pons Varolii, tubercula quadrigemina, crura cerebri, crura cerebelli, and medulla oblongata.

Cerebellar Peduncles, are three on each side, superior, middle, and inferior; the superior are thick, round, white cords (processus a cerebello ad testes), which pass downwards and backwards, diverging from the testes to the central white portion of the cerebellum; corresponding internally, to the fourth ventricle and valve of Vieussens; externally and inferiorly, to the middle crura; and superiorly, to the cerebellum, where they afford origin to the fourth nerve. Middle peduncles, or crura cerebelli, pass from the cerebellum to the side of the pons, which they enter, forming its transverse fibres; they are related behind to the seventh, in front to the fifth pair of nerves, and inferiorly to the subpeduncular flocculus, or pneumogastric lobule. Inferior peduncles are constituted by the restiform bodies, which diverge, and enter directly the inferior part of the incisura anterior, and so into the cerebellum, without passing through the pons.

Internal Structure of the Cerebellum.—A longitudinal section on either side of the middle line displays the *arbor vitæ* of the lateral lobes, and a similar section in the mesian line, that of the middle lobe; the former consisting of a central white nucleus, which gives off at its circumference from fifteen to twenty branches, and these, again subdividing, are covered at their extremities by a yellow layer, on which, lastly, is moulded the grey substance, which is about a line in thickness. In the centre of each white nucleus, a mass of grey matter (corpus rhomboideum) occurs, of an ovoid figure, possessing also a yellowish investing surface layer; this, Gall and Spurzheim conceived to be the ganglion of the cerebellum. The arbor vitæ of the middle lobe, consists of a triangular white nucleus, which is continued upwards into the superior, and downwards into the inferior vermiform process, dividing and subdividing into a successive series of branches as they pass to the surface, where they are surrounded by a yellow layer, and grey substance, the arrangement of which is similar to that of the same parts in the lateral lobes.

MEDULLA OBLONGATA.

Medulla Oblongata, or, Rachidian Bulb, is a conoid enlargement, extending from the pons Varolii above, to the upper margin of the anterior half arch of the atlas below, where a slight constriction indicates its junction with the medulla spinalis. It measures in length from fifteen to sixteen lines, in breadth about nine, and in thickness six, its diameter being much greater than that of the spinal cord; its direction is oblique, and it therefore forms an obtuse angle with the spinal cord, salient posteriorly; inferiorly, it rests on the basilar process of the occipital bone, and also corre-

sponds to the vertebral arteries; while superiorly and posteriorly, it is related to the fourth ventricle, and valley of Haller. It consists of four bodies, which are symmetrical,—namely, the anterior pyramids in front, the olivary bodies laterally, the restiform posteriorly and laterally, and the posterior pyramids behind.

Anterior Pyramids, occupy the anterior part of the medulla, are triangular in shape, and about an inch in length; each commences narrow and pointed below, by three sets of fibres,—namely, decussating, non-decussating, and arciform; the first set consists of from three to five fasciculi, which sink into the anterior sulcus, to become continuous with the antero-lateral columns of the cord on the opposite side; the second set more external, are prolonged to the anterior column of their own side; while the third set, or the arciform, still more external, pass backwards around the olivary body, the lower part of which they cover, and become continuous with the posterior columns. Above the point of decussation, a median fissure separates these bodies, and on gently drawing them asunder, the inner edge then appears dentated, in consequence of the impressions made on it by the vessels of the pia mater, which sinks into the fissure. Immediately before they enter the pons they become round, and consequently a small depression (foramen cœcum), bounded above, and in front, by the pons, results between them; they now dip into the latter body above the transverse fibres on its superficial surface, but crossing others which are deeper, and reaching the crura cerebri, pass through their anterior and external part, to arrive at the optic thalami and striated bodies, in their course to the hemispheres; in the medulla oblongata, they are separated from the olivary bodies by a groove from which the ninth nerve arises, while from their superior part immediately behind and below the pons, the sixth pair of nerves take their origin.

Olivary Bodies, are small, oval projections, one on each side of the medulla; bounded behind, by a depression which separates them from the restiform bodies, and from which arise the eighth pair of nerves; in front, from the pyramidal by the groove above mentioned for the origin of the ninth pair; above, by a depression in which the portio dura arises; and below, by the arciform fibres. On tracing them downwards, their fibres are seen to become continuous with the antero-lateral column of the cord; while superiorly, although apparently separated from the pons by a depression, still they enter that body, and, having passed through it, form the greater portion of the upper part of the crura cerebri, when they subsequently enter the optic thalami and the tubercula quadrigemina. If the anterior pyramids are removed, and the olivary body is subjected to the action of a stream of water, a yellowish mass will be seen,

which, from its resemblance to a folded leaf, is called corpus dendroideum, and which can be traced inwards, into the substance of the medulla, as the fillet of Reil. The olivary body is, therefore, hollow internally, and has been compared by Rolando to an open purse, and hence he named it "borsa appiattita." Gall and Spurzheim conceived that these bodies, which are peculiar to the human subject, were the ganglia of increase connected with the medulla oblongata.

Restiform Bodies.—Round and cylindrical like a rope, from which circumstance their name is derived, are found on the posterior and lateral part of the medulla; they are derived inferiorly from the posterior, and postero-lateral columns of the cord; while superiorly curving backwards and outwards, as the inferior crura cerebelli, they enter the cerebellum, and form its diverging fibres. The restiform bodies are separated from the olivary, by the groove for the eighth nerve; while between them, as they diverge in their ascent towards the nodus cerebri, the posterior pyramids, with the calamus scriptorius, and the median fissure (posterior), become evident.

Posterior Pyramids, are two small bands of white medullary substance, on the posterior surface of the medulla, separated from the restiform bodies by a superficial, and from each other, by the posterior median sulcus; they are about one-eighth of an inch in width, and are formed by the posterior, and a part of the lateral columns of the cord; the latter decussating, like the fibres of the anterior pyramids. These bodies are then continued upwards, passing through the pons, crura cerebri, and optic thalami, and from thence to the convolutions of the brain.

Calamus Scriptorius.—The posterior surface of the medulla, which is concealed by the cerebellum, appears to open out or become everted, so that the central grey matter is exposed; and as the posterior columns separate in their ascent, a triangular interval occurs between them, with its apex inferiorly, which, from its resemblance to a writing pen, has been named the calamus scriptorius. The shaft of the pen is formed by the median sulcus, and also by white medullary lines which pass upwards, forwards, and outwards, varying in number and size, some terminating after a short course on the inferior wall of the fourth ventricle, while the greater number are continuous with the origin of the portio mollis nerve. The point of the pen is formed at the angle of separation of the posterior calamus, where a small fossette is visible, into which a bristle can be passed for about a quarter of an inch, but no farther.

Sections of the Medulla.—If a transverse section is made immediately below the pyramids, the grey matter appears similar in its

arrangement to that in the spinal cord; but if the section is made opposite the inferior third of the pyramids, the grey matter appears irregularly diffused through the two posterior thirds of the segment; and lastly, a section opposite the centre of the olivary bodies will display, in addition to the central grey matter of the cord, likewise the yellowish grey corpus dentatum of those bodies.

Formation of the Brain.—It is usual to describe the brain as consisting of four sets of fibres, namely, diverging, converging, commissural, and fibres of conjunction. Assuming the medulla oblongata as their primordial centre, we will first proceed to trace generally those fibres in the cerebrum proper, and subsequently in the cerebellum; but should the student be desirous of following them in their course, it will be requisite to obtain a brain hardened in alcohol, or boiled in oil; when, having removed the arachnoid and pia mater, he may then proceed to unravel the cerebral fibres with a wooden scalpel, and two or three portions of hard wood, of which one should be made extremely fine, and the other forked at the extremity, while he should also have the requisite means for allowing a stream of water to play on the preparation. It is, however, a very troublesome operation, and one that requires great patience and address for its accomplishment.

The Diverging Fibres of the Cerebrum, are continuations from the anterior and posterior pyramids, as well as from the olivary bodies, and they may be traced generally as entering the pons Varolii, and passing through the corpus rhomboideum (or the ganglion of the pons), when they seem augmented in size and number; then, continuing their course into the crura cerebri, and coming in contact with the locus niger, which separates the olivary from the pyramidal fibres, they again appear increased in bulk; they then enter the optic thalamus and striated bodies, in which they become blended and interwoven with their grey neurine; proceeding now outwards to reach the grey substance which covers the hemispheres, or to that yellowish line internal to the grey border, named the linea flava of Soemmering, they become looped, by turning on themselves to reach the middle line, and terminate in the *commissures*, which are, the corpus callosum, fornix, anterior, middle, and posterior commissures, middle perforated plate, &c. Thus the diverging fibres have their origins in the medulla oblongata, and by their subsequent reflections on themselves, constitute the converging fibres.

Diverging Fibres of the Cerebellum.—The restiform bodies, passing backwards and outwards, enter the inferior part of the incisura anterior, when they diverge in their progress through the corpora rhomboidea, and terminate at the surface grey layer; from this point, the converging fibres turn inwards, to form the middle crura

cerebelli, the transverse fibres of the pons forming their commissure. The superior peduncles connect the middle lobe of the cerebellum to the tubercula quadrigemina, the valve of Vieussens constituting the commissure between them (Gall); but with equal reason the vermiform processes may be assumed to be the commissures of the inferior peduncles or restiform bodies, as they are not only continuous with their fibres, but likewise unite the lateral and middle lobes, by their transverse bands. The following tabular view from Dr. Carpenter's work, will facilitate the student in understanding the preceding description:—

SPINAL CORD.	MEDULLA OBLONGATA.	BRAIN.
Anterior columns,	Arciform fibres of cerebellar columns.	Cerebellum; Corpora quadrigemina.
	Olivary columns.	
	Non-decussating portion of anterior pyramids.	Corpora striata.
Middle columns,	Decussating portion of anterior pyramids.	
	Posterior pyramidal columns (decussating).	Thalami optici.
	Posterior pyramidal columns (non-decussating).	
Posterior columns,	Restiform columns.	Cerebellum.

Development of the several parts of the Brain.—The medulla oblongata appears about the third week of fœtal life, and up to the third month is not limited superiorly; it is not until the commencement of the fourth month that the pons Varolii becomes evident, when it consists merely of transverse fibres. The cerebellum appears immediately after the medulla, being at first a single vesicular mass, formed by the coalition of the restiform bodies; but at the twelfth week, it forms a circular band, about one-third of an inch in width, surrounding the upper part of the medulla, and the tubercula quadrigemina, though as yet deficient of laminæ or fissures. At the sixth month, the posterior notch with the surface fissures, becomes evident, and during the further period of fœtal life, the lateral lobes increase, so as ultimately to conceal the middle. The cerebrum, at the end of the eighth week, presents the corpora striata covered by a thin fold of membrane, representing the cerebral hemispheres, but this vesicular enlargement still leaves the optic thalami, tubercula quadrigemina, and cerebellum exposed, the corpus callosum not as yet being formed, the whole mass resembling the brain of fishes. At the end of the twelfth week, the nascent hemisphere covers also the optic thalami, and now the corpus callosum also begins to appear, as a narrow band. In the fifth month, the hemisphere covers the tubercula quadrigemina, and traces of anfractuosities, with the fissures of

Sylvius, are observed. In the sixth month, they conceal the anterior part of the cerebellum ; in the sixth, and seventh months, the cerebellum becomes entirely concealed, the posterior cerebral lobes projecting behind it ; and during the remainder of fœtal life, the convolutions become more perfect, and the corpus callosum reaches the tubercula quadrigemina.

The weight of the brain, varies with age and sex : in the male, its average weight may be stated as about three pounds ; while in the female, it is about two pounds ten ounces ; but this average is only approximate, as it has been known in some remarkable instances to have far exceeded the weight specified.

DISSECTION OF THE SPINAL CORD.

In order to examine this important part, the subject must be placed on a table, with blocks beneath the chest and abdomen, so that the muscles of the back, may become tense ; an incision should then be carried perpendicularly downwards on either side, three inches external to the spines, from the occiput to the base of the coccyx ; the great erectors of the spine must then be removed, and the posterior half-arches of the vertebræ exposed ; those arches should next be divided either with the saw, or, what is still better, with a mallet and chisel, close to the pedicles, and each of them cautiously lifted up ; by this means the interior of the canal will be exposed ; but the dura mater, or first covering of the spinal cord, is not as yet fully displayed, being invested by a layer of watery adipose tissue, forming the bed or stroma for numerous plexuses of veins (Rachidian) which ramify on it, in every direction. When the Rachidian veins have been carefully examined, the cord may be next removed from the canal ; and this can always be effected with the greatest facility, by commencing below, and first cutting the nerves constituting the cauda equina, as they issue from the sacral foramina, and then dividing the others in succession, as high up as the cranium ; the fibrous bands, which connect the dura mater to the posterior vaginal ligament, must likewise be cut across ; and ultimately, the knife may be swept through the entire structure, immediately below the foramen magnum, when it thus becomes detached for examination. The membranes of the cord, are three in number, all continuous with those of the brain—an external or fibrous, derived from the dura mater ; a middle or serous, prolonged from the arachnoid ; and an internal or areolo-vascular, a continuation of the pia mater.

Dura Mater.—A tubular prolongation from that of the cranium, expanded at both extremities, but contracted in the middle ; attached firmly above, around the margin of the foramen magnum ; and ter-

minating below, at the inferior part of the lumbar region, where it forms a well-marked dilatation, from which separate processes are given off, to constitute sheaths for the nerves of the cauda equina. Its external surface, smoother than that which lines the cavity of the skull, does not form a perfect periosteum for the bony case in which it is enclosed, as it only adheres to it at a few detached points; but its internal, is remarkable for its glistening, polished appearance, a character which it derives from the visceral layer of the arachnoid. It is perforated along its sides, by a double row of foramina, thirty-one pairs, for the passage of the anterior and posterior spinal nerves, and a tubular prolongation from its structure is reflected upon them as a neurilemma or sheath, after they emerge. The differences between it, and the dura mater of the brain, may therefore be thus recapitulated:—Firstly, it does not form a perfect periosteum, but is separated from the walls of the canal, by loose watery areolar tissue, with the Rachidian veins, and posterior vaginal ligament; secondly, it does not form sinuses, neither does it, like that of the brain, send prolongations or processes into the structure which it invests; thirdly, it is much thinner, and presents the fibrous character in a less marked degree; and fourthly, it is less vascular, and adheres less intimately to the subjacent arachnoid. It must not however, be supposed that it closely invests the cord, as it is in reality much too large for it, and the interval which exists between them, is there for the purpose of affording space for the subarachnoid fluid, which is always found in the canal, in some quantity.

Structure.—Is essentially fibrous, but not so strong as that of the brain, and its vascular supply is derived from the following sources: viz., deep cervical, intercostal, lumbar, and sacral, while its veins terminate in those of the Rachidian system. With respect to its nerves, it has not as yet been clearly demonstrated, whether they exist at all.

Arachnoid, is the serous envelope of the cord, continuous with that of the cranium, and is equally remarkable for its delicacy and tenuity; it consists of two layers,—an external or parietal, and an internal or visceral; the former, lining the entire of the outer fibrous membrane just described, and sending off around each of the nerves, as they escape through its foramina, processes which are again reflected back within the sheaths, in *cul de sacs;* the visceral layer, embracing the cord very loosely, allows an interval of variable capacity to exist between it and the pia mater, which can be clearly demonstrated either by inflation or injection of any liquid material; this interval called the *subarachnoid space* was first pointed out by Haller, afterwards by Contugno, and lastly by Magendie, whose direct experiments conclusively establish the fact of its existence. The subarachnoid

fluid is thin and transparent; it surrounds the cord in all directions, and defends it from those shocks and concussions to which it would have been otherwise liable, from the manner in which it is encased within its bony canal ; it communicates freely, with similar spaces in the cranium, and, according to some authors, with the ventricles of the brain. Long fibrous filaments, described by Rainey as nervous, connect the loose sac of the arachnoid with the subjacent pia mater, and in the mesial line, on the posterior aspect of the cord, a species of septum, sometimes imperfect or cribriform, appears to unite both, one to the other (Sharpey). The continuity of the visceral with the parietal layer, is preserved by the reflection of the membrane, in a series of tubules, on the nerves and vessels.

Pia Mater, forms the immediate investment of the cord, and is continuous with the same structure of the brain ; but it differs from the latter in several important particulars, being more fibrous in its character, and having very little vascularity ; it invests the cord most tensely, as may be shown by puncturing it, when a hernia of the neurine will immediately occur through the aperture ; while it sends into the anterior median furrow a dense process (membrana resplendens of Haller), and a smaller and less obvious one into the posterior ; it likewise throws off a neurilemma around each of the nerves as they pass through it, and inferiorly, terminates in a thin filament (filum terminale), which is prolonged downwards, in the centre of the cauda equina, surrounded by a tubule of dura mater, until it becomes ultimately attached to the lower part of the canal of the coccyx ; this process was formerly regarded, by the older anatomists, as a prolongation of the cord itself, to which they applied the name *nervus impar*. On tracing the pia mater upwards, from the medulla oblongata, a gradual change in its character will be observed to take place ; it imperceptibly becomes more areolar, and its vessels more numerous, as it spreads out to invest the tissue of the brain.

Ligamentum Denticulatum, is a flattened band of fibrous tissue, extending from the foramen magnum above, to the first lumbar vertebra below ; presenting an internal plane margin, which is thin, and attached to the pia mater of the lateral part of the cord, between the anterior and posterior roots of the nerves ; and an external, thicker, and deeply serrated, having twenty-one or twenty-two distinct teeth. Of these, the first is the longest, and is attached to the margin of the foramen magnum, where it separates the vertebral artery, from the lingual and spinal accessory nerves ; while all the others are in a similar manner, connected by their points, to the intervals between the foramina of emergence of the anterior and posterior nerves, which they thus serve to separate, while at the same time they tend to keep the cord itself accurately fixed in its position,

and preserve it from concussion against the walls of its bony case. Various opinions have been advanced as to the nature of this ligament, some asserting that it is a separate structure; others, that it is a process of the dura mater; others, of the arachnoid; and others again, of the pia mater; the last, however, would appear to be the correct view of its formation.

Having thus completed the examination of its investing tissues, the cord itself should next be exposed; and this may be done by cautiously removing the pia mater, always a difficult operation, as it adheres to it very closely, particularly in the vicinity of the origins of the nerves.

The Spinal Marrow, in the human subject, averages a length of from fifteen to eighteen inches, commencing opposite the ring of the first cervical vertebra, and terminating at the inferior margin of the second lumbar; it must not, however, be assumed that either of these points is invariably the same in all individuals, as, besides exceptional discrepancies, flexion and extension of the head may influence the position of the one, and similar movements of the vertebral column may alter that of the other. In intra-uterine life the cord reaches downwards as far as the coccyx, but in the infant at birth only as far as the fourth lumbar vertebra. Cylindrical in shape, but slightly flattened both on its anterior and posterior aspects, it presents two well marked dilatations (we exclude at present that of the medulla oblongata),—the superior or cervico-brachial bulb above, oval in figure, extending from the third cervical to the third dorsal vertebra; and an inferior or dorso-lumbar below, pyriform, with the base superiorly at the eleventh dorsal, and the apex inferiorly at the second lumbar, where it terminates in the filum terminale. These enlargements are obviously attributable to those large nervous masses, which are thrown off from the cord, at those points, viz.:— the brachial above, and the lumbar and sacral below; but in the dorsal region, a similar increase in size and structure is not required, as, although respiration is a most important function, still the muscles which are subservient to it, do not depend for their supply on those nerves only which arise in the immediate vicinity of the thoracic cavity, but they borrow others from sources more remote; and this is done, in order to obviate the dangerous results that might ensue, from the accidental lesion of any particular part of the nervous centre, in a function so essential to existence.

The cord presents, both on its anterior and posterior surfaces, a groove or furrow, but the one differs from the other in the following particulars:—While the anterior is broad but shallow, dipping into the structure for about one-third of its entire depth, and limited in its deeper part by a thin band of white neurine, stretching completely

across it; the posterior, on the contrary, is much narrower, scarcely visible at first, and requiring the opposite sides of the cord to be gently drawn apart, before it becomes apparent; it extends into the substance of the cord for nearly two-thirds of its thickness, and its floor is formed by a delicate grey lamina extending across it. From this view, it will be perceived that the spinal marrow consists, truly speaking, of two cylinders, united by a thin commissure, white anteriorly and grey posteriorly, each cylinder being composed essentially of an external envelope of white neurine, within which is deposited a grey mass, semilunar in figure, with its convex margin directed towards that of the other, and with a commissure of the same colour and consistence connecting them. The arrangement just described, may be distinctly observed, by making a transverse section of the cord. In addition to the median furrows already mentioned, two others are also visible on each side, an antero-lateral and postero-lateral; but both are not equally well marked, the latter being the more deeply indented, while the former is the more curved, from commencing on the side above, and terminating on the front below; these grooves are separated from each other, when the cord is in situ, by the attachment of the ligamentum denticulatum. We have stated above, that a transverse section of the cord will reveal its two great constituent parts, the grey and the white; the latter however, in this instance, forming the external layer and investing the former; the figure of the included grey, from the two crescentic masses of which it is composed, and from being united in the mesial line, resembles the letter X, but with this difference, that the posterior horn of the crescent of which each side is formed, is much longer and sharper than the anterior, reaching out in fact as far as the postero-lateral furrow, and affording direct origin to the posterior roots of the spinal nerves; while the anterior, which is rounded and blunt, terminates about two lines before it arrives at the antero-lateral or corresponding fissure, and the anterior roots of the nerves cannot be directly traced into it.

The Spinal Nerves, consist of thirty-one pair on each side, viz.: eight cervical, twelve dorsal, five lumbar, and six sacral, arising from the secondary grooves or furrows, already described, on either side of the ligamentum denticulatum. In their characters the two roots are very different,—the anterior, being white, hard, and small; and the posterior, grey, soft, and large. Much diversity of opinion prevails, as to the manner, in which the nerves originate from the spinal marrow; but the more general idea appears to be, that they arise by two sets of filaments, one of which becomes fused or blended with the grey or vesicular mass in the centre of the cord, whilo the other passes upwards and inwards through its structure, and is sup-

posed to terminate in the brain itself. On leaving the spinal cord, each nerve receives an investing tubule from the pia mater, and an inflection from the arachnoid; they then perforate the dura mater by distinct foramina, obtaining likewise an investiture from that structure; and, emerging into the vertebral foramina, the posterior root dilates into a soft, grey, oval ganglion, to the anterior face of which the hard root is applied, or, more strictly speaking, is imbedded in it; yet there appears to be no direct communication of their fibres, but after the formation of the ganglion, the posterior nerve is again collected into a plexiform cord, which unites inextricably with the anterior, and immediately after this common fusion, a division into two trunks again ensues, and of these the anterior is now decidedly the larger. This ultimate destination will subsequently be traced, in the description of the plexuses; but it may perhaps be necessary to observe here, that the origin of the posterior nerves is much nearer the corresponding median furrow, than the anterior; the former, being also more intimately connected with the structure in front of its own proper fissure.

In the earlier periods of intra-uterine life, the spinal marrow consists of merely a thin, transparent, pulpy mass, extending the entire length of the spinal canal, and being relatively much larger than the brain; it afterwards assumes a laminated appearance, which, bending backwards on itself, forms a complete canal, which is continuous with the cavity of the fourth ventricle; but the dense pia mater pressing upon it about its centre, from before backwards, causes the approximation of its anterior and posterior walls, by which it is converted into two distinct tubules. This condition continues, to about the sixth month, when the canals become obliterated by new deposits, which are gradually added to their inclosing tissues; but still the parts have not as yet assumed a perfectly consolidated character, as the slightest inflation will again re-produce the appearance of those cavities. At this period of life, the white matter which invests the cord is extremely thin, and the posterior columns are remarkable for their greater degree of development and firmness, as contrasted with the anterior. It should be also recollected that in fœtal life the cord extended the entire length of the canal; but in consequence of the rapid elongation of the cervical region, it is gradually carried upwards, the filum terminale alone, remaining as the vestige of its sacral portion.

CEREBRAL NERVES.

The Cerebral Nerves consist of nine pairs, and are divided into motor, sensitive, compound, and nerves of special sense. Taking them in order, from before backwards, it will be found that the first pair are

called the olfactory; the second, optic; the third, motores oculorum; the fourth, trochleatores; the fifth, trifacial, or trigemini; the sixth, abducentes; the seventh, consisting of two, are termed auditory and facial; the eighth, of three, the pneumogastric, glosso-pharyngeal, and spinal accessory; and the ninth is known as the lingual, or the hypo-glossal. Of these, the third, fourth, one portion of the fifth, sixth, portio dura of the seventh, spinal accessory, and lingual, are motor; the soft root of the fifth pair, the pneumogastric and glosso-pharyngeal, are sensitive; and the fifth, taking the anterior and posterior roots conjointly, affords a good example of a compound nerve; while the nerves of special sense include the olfactory, optic, auditory, and the gustatory branch of the fifth.

Olfactory, or First Pair.—Each olfactory nerve, arises by three roots,—an external, middle, and internal; the external, long, slender, and white, takes its origin from the most posterior convolution in the Sylvian fissure, where it is continued into the corpus striatum, and communicates with the fibres of the anterior commissure; the middle, which is grey, arises from the most posterior convolution of the anterior lobe of the brain (caruncula mammillaris); while the internal, white and small, sometimes double, and of a silvery colour, takes its origin from the innermost lobule of the anterior lobe, and is continued inwards to the rostrum of the corpus callosum; the three roots converge, and ultimately unite to form a prismatic trunk, which passing forwards and inwards, is imbedded in a sulcus on the anterior lobe, lying above the arachnoid, and below the pia mater, with the grey filament forming the apex of the prism; on the cribriform plate of the ethmoid bone it expands, forming an oval bulb of a light grey colour (olivary ganglion), soft, and devoid of neurilemma, and separated from its fellow by the crista galli; while inferiorly, it is supported by the dura mater, body of the sphenoid, and cribriform plate of the ethmoid bone, occasionally extending so far forwards that it conceals the nasal branch of the ophthalmic nerve. From the inferior surface of the bulb, three sets of branches pass off, namely, external, middle, and internal, which descend through similarly arranged foramina in the cribriform plate of the ethmoid bone, each branch being surrounded by a process of the dura mater, which passes into the nasal cavity to become continuous with the fibrous layer of the Schneiderian membrane. The arachnoid also follows each branch for some distance into these canals, but again abandoning it, and forming a *cul de sac*, ascends to re-enter the cranium, while the pia mater likewise accompanies the nervous filaments; after a short course in these canals, the dura mater becomes intimately adherent to them, conferring on them a great power of resistance, and rendering it difficult to break down the bone, without at

the same time destroying the nerves. Of the branches, the external are distributed to the pituitary membrane, on the middle and superior spongy bones, the internal to the septum, and the middle to the roof of the organ.

The olfactory nerves are peculiar in the lower vertebrata, from the olfactory bulb being the seat of a cavity which communicates with the lateral ventricle, an organization absent in man. These nerves are likewise exceptional, in arising by three roots of different shades of colour, in converging within the cranium, in their prismatic form, in lying in a deep sulcus or furrow, in being above the arachnoid, and devoid of neurilemma, in leaving the cranium by a number of foramina, and in not possessing the power to excite reflex action. The olfactory nerves are sometimes, but rarely, absent; and when such a deficiency exists, the sense of smell is also wanting.

Optic Nerves, or Second Pair.—In order to see the origins of these nerves, the corpus callosum, fornix, velum interpositum, pineal gland, and superior vermiform process of the cerebellum, should be raised; and to be able to follow them forwards, as they wind around the crus cerebri, the inferior cornu of the lateral ventricle should be laid open, and the arachnoid and pia mater, carefully removed. Each nerve arises by two roots, one from the nates, the other from the testes, and these passing forwards, are next attached to the corpora geniculata externa and interna; forming now a flattened band, it runs downwards, forwards, and inwards, winding round the crus cerebri, from which it likewise takes an origin, here constituting the tractus opticus; next, converging towards its fellow, they both unite in the optic chiasma, or commissure, which may be said to derive a sixth attachment from the tuber cinereum. The *chiasma*, in figure resembling a Maltese cross, being related posteriorly to the tuber cinereum, above and before to the grey floor of the third ventricle, which attaches it to the brain, below to the olivary process of the sphenoid bone, and externally, to the carotid artery, and external perforated plate. It consists of three sets of fibres—non-decussating, decussating, and commissural; the first, which are the most external, pass on to the eye on their own side; the second, or middle set, crossing the centre of the chiasma, supply the inner part of the retina of the opposite side; whilst the third, or most internal, behind the chiasma, run forwards, and are then reflected backwards, being the commissural fibres of origin; and again, in front of the chiasma, running from the retina of one side backwards, they again turn forwards to that of the opposite eye, constituting the commissural fibres of termination; another decussation has likewise been supposed, that from above downwards, but without positively questioning its existence, we are however, bound to confess, even after the most careful

preparation, that such an arrangement has eluded our observation. The optic nerves, now springing from the front of the commissure, pass outwards and forwards, lying below the anterior cerebral arteries, and above the lesser wings of the sphenoid bone, which they groove; and entering the optic foramen, become surrounded by a dense sheath of dura mater, which constricts them as they run through the hole; continuing their course forwards and outwards until they reach the globe of the eye, they perforate the sclerotic coat by a cribriform, and the choroid by a well-defined aperture, when they ultimately expand to form the retina. On passing from the chiasma to the optic foramen, the nerve lies superior and internal to the deep carotid artery; and here, the ophthalmic lies to its outer side, but afterwards winds round it to its internal. In the orbit, it is surrounded by the recti muscles, and ciliary nerves, but has in addition the following parts in connection with it:—

Relations.—Above, the superior division of the third, and nasal nerves; externally, the lenticular ganglion, its roots, and the opthalmic artery, and vein; internally, the naso-ciliary branches; and inferiorly, the inferior oblique division of the third.

The optic nerves consist of very delicate filaments, similar to those of the brain and cord; and show the same disposition to become varicose when subjected to pressure, as exhibited by the olfactory, and seventh pair. We may here remark, that a perfect decussation of the nervous filaments occurs in the chiasma of fishes.

Third Pair, or Motores Oculorum, white and round, arise each from the inner edge of the crus cerebri, where it emerges from the pons; but this origin is merely apparent, as the filaments may be traced into the locus niger; from this point they pass a little backwards and downwards, in order to escape between the anterior cerebellar and posterior cerebral arteries, and winding round the latter, pass upwards, forwards, and outwards, internal to the posterior communicating artery, through the fine areolar tissue of the middle subarachnoid space; each nerve next runs between the attachment of the convex and concave margins of the tentorium, and entering the outer wall of the cavernous sinus, lies above the fourth in the two posterior thirds of that space, but below it in the anterior; it now becomes flattened, and divides into a superior and inferior division, both of which enter the orbit by the sphenoidal fissure, between the two heads of the external rectus; the superior division, the smaller, as it enters the fissure, has above it the frontal nerve, and one head of the external rectus; and immediately beneath it, the optic and nasal, from which it receives a communicating branch; continuing its course forwards and inwards, it divides into two branches, of which the superior, or the larger, winding round the inner margin of the su-

perior rectus, near its back part, and lying on the superior surface of that muscle for a short distance, where it is flattened, sinks into the deep aspect of the levator palpebræ superioris, in which the filaments of the nerve may be traced to its palpebral attachment; while the second, or inferior of the two, enters and supplies the ocular surface of the superior rectus muscle. The inferior division, on entering the foramen lacerum orbitale, lies below the superior division and the nasal, and above the sixth nerve; then passing forwards, and lying inferior and external to the optic nerve, it divides into three branches,—an external, middle, and internal; of these, the first, which is the largest, gives off immediately after its origin, the short root to the lenticular ganglion, and then running beneath the optic nerve, and on the ocular surface of the inferior rectus, winds round the outer margin of that muscle, and sinking beneath it, supplies the ocular aspect of the inferior oblique; the second, or middle branch, sinks into the ocular aspect of the inferior rectus; whilst the third or internal, larger than the last, and flattened transversely, passes inwards beneath the optic nerve, and above the inferior rectus, and supplies the deep surface of the internal rectus. It will be thus seen, that the third nerve supplies five out of the seven muscles in the orbit, all on that aspect which is turned towards the eye; and from the peculiar relation which the nerve bears, immediately after its origin, to the cerebral and cerebellar arteries, affections of its motor function are frequently associated with cerebral vascular derangement, producing a drooping of the upper eyelid, or *ptosis;* but in addition to the levator palpebræ, all the other muscles supplied by the nerve participate in the loss of power, the eye being, therefore, drawn downwards and outwards by the external rectus and superior oblique, which are supplied from quite a different source.

Fourth or Trochleator Nerves, sometimes called *pathetici*, and extremely small and fine, like a thread, arise usually by two filaments, from the valve of Vieussens and the processus a cerebello ad testes, a transverse white band occasionally acting as a commissure between them; and here they are covered directly by the velum interpositum; they now pass forwards and outwards, winding round the meso-cephalon, and lying between the cerebrum and cerebellum, enter a canal between the laminæ of the tentorium, and are received between the layers of the outer wall of the cavernous sinus, where they lie at first above the ophthalmic, and below the third, but after some distance they mount above the latter; they next enter the sphenoidal fissure at its base, between the periosteum above, and the frontal nerve inferiorly and externally, and crossing the superior rectus and levator palpebræ, become flattened, and are distributed

to the orbital surface of the superior oblique muscles, near their posterior extremities.

Recurrent Branch.—Whilst within the cavernous sinus, each gives off a recurrent branch, which runs backwards and outwards between the layers of the tentorium, in which it terminates; sometimes, this branch also receives a filament from the opthalmic. The fourth was considered by Sir C. Bell as the respiratory nerve of the orbit, being the highest nerve of that superadded system, arising from the respiratory tract. In the cavernous sinus, it is intimately connected with the opthalmic; and this has induced some anatomists to consider it as an additional root of that nerve, while others, founding their arguments on its distribution, believe it to be, in some way, connected with the common motor nerve of the orbit. It is, however, a curious fact, that the lachrymal branch of the opthalmic almost constantly receives from it, a branch of communication; and in a case where the former was totally absent, it was replaced by a filament from the latter; there would appear therefore good ground for inferring that the trochleator should be considered as a compound nerve.

Fifth Nerve, Trifacial or Trigemini, consists of two roots—one white, round, small, and hard; and the other soft, grey, large, and ganglionic; these two roots are seen in front of the crus cerebelli, which constitutes the apparent origin of the nerve, but its real one can be traced through the pons, downwards to the olivary tracts of the medulla, or as Dr. Alcock remarks, to the floor of the fourth ventricle, where they arise above the auditory nerve, from a yellowish grey layer, which connects them with the anterior and posterior columns of the cord. The soft root, emerges through an elliptical aperture between the transverse fibres of the pons; while the hard, or smaller escapes through a distinct rounded opening, separated from the former by a small papillar enlargement, and lying on its superior and posterior border. The soft root, consists of from seventy to one hundred filaments, and if the nerve is forcibly torn from its attachment, a mammillary tubercle remains, which Bichat conceived constituted its origin; it always seems constricted when passing from the pons, but beyond that point it becomes enlarged and rounded; while the hard root, which was situated on its superior and posterior margin, now appears on its internal aspect, where it is retained in a groove, by a fold of arachnoid, which is common to both nerves. They now run forwards and outwards beneath the tentorium, supported by a fold of arachnoid membrane, and passing through an oval aperture, above the superior angle of the petrous portion of the temporal bone, and below the superior petrosal sinus, are received into a depression on its superior surface, where the soft portion expands and

forms the Casserian ganglion, beneath which and the formative nerve, and between them and the bone, a double fold of arachnoid is prolonged, but it does not cover at all their upper surface; and hence, while the dura mater adheres most closely to the nerve and ganglion superiorly, and can be removed only with difficulty, it can be detached with great facility, both from the nerve and ganglion, inferiorly.

Casserian or Semilunar Ganglion, is of a light grey colour, concave posteriorly and internally, and convex anteriorly and externally; it receives posteriorly the soft root of the fifth, while from its convexity three branches emanate, namely, the ophthalmic, superior and inferior maxillary; the inferior surface, convex, corresponds to the depression in the bone, the following superposition of parts being situated beneath it:—1. The hard root; 2. A double layer of arachnoid; 3. Dura mater; 4. Vidian nerve, with the Vidian branch of the middle meningeal artery, and occasionally the small petrosal nerve. The superior surface, concave, rough, and plexiform, is intimately united to the dura mater, which covers it, and looks upwards, forwards, and outwards. The recess in which the ganglion is situated represents a conoid triangle, with the base anteriorly and externally, and the apex posteriorly and internally, and is separated from the cavernous sinus by a layer from the convex edge of the tentorium; it is bounded in front, by the internal carotid artery; externally, by the middle meningeal artery; posteriorly, by the aqueduct of Fallopius, Vidian nerve, and artery; and internally, by the superior petrosal sinus. The septum in front, derived from the tentorium anteriorly or at the base, exhibits three funnel-shaped apertures, the highest and smallest for the ophthalmic; the middle both in size and position, for the superior maxillary; and the most inferior, the largest, for the inferior maxillary nerve—the last being sometimes divided by a narrow septum into two openings, the smaller of which transmits the hard root, and the larger the trunk from the ganglion itself, while from the margins of the apertures, processes are sent on each nerve as it escapes.

Ophthalmic Nerve, arises from the superior anterior angle of the ganglion, and passing upwards, forwards, and inwards, enters the outer wall of the cavernous sinus, being here somewhat flattened, with the superior margin directed internally, and the inferior, externally; superiorly, it corresponds to the fourth, with which it is closely united, but near the sphenoidal fissure it loses that nerve, and becomes related to the third, while the sixth lies below, and at first internal but afterwards external to it, in consequence of the latter crossing from within outwards to reach the external rectus; immediately behind the sphenoidal fissure, the ophthalmic divides into

three branches, viz., lachrymal, frontal, and nasal, of which the first is the smallest, the second the largest, and the third intermediate in size between the other two.

Lachrymal Nerve, extremely small, enters the orbit surrounded by a tubule of dura mater, through the apex of the sphenoidal fissure, lying above the nasal, and below the superior division of the third; it passes forwards and outwards, along the upper edge of the external rectus muscle, accompanied by the lachrymal artery, and divides into three sets of filaments—glandular, palpebral, and communicating; the first, very numerous and flat, enter the osteal surface of the gland, in which they terminate; the second, consisting usually of two filaments, pass either through, or between the gland and the bone; then pierce the palpebral ligament, and descending a little, one (temporal) passes upwards and outwards, to be lost in the skin on the anterior part of the temporal region; while the other, running inwards, above the ciliary margin of the lid, communicates internally with the supratrochleator branch of the ~~fourth~~ Front, to form the superior tarsal arch of nerves; the third, or communicating, runs downwards and outwards, on the external wall of the orbit, and communicates with a twig of the orbital division of the superior maxillary; from the loop thus formed, two nerves arise, one the subcutaneus malæ, which passes through the malar bone, where it is covered by the orbicularis palpebrarum, which it perforates to reach the skin of the cheek and lower lid, and communicates with branches of the portio dura; the other, the temporo-malar, also pierces the malar bone under the temporal muscle, through which it escapes to supply the skin over the external angular process of the os frontis. The lachrymal nerve receives a branch of communication from the fourth in the cavernous sinus, but it is so very small that it frequently escapes notice.

Frontal Nerve.—The largest division of the ophthalmic, enters the orbit through the sphenoidal fissure, lying inferior and external to the fourth, and above the superior division of the third, from which it is separated by the levator palpebræ, superior rectus, and one head of the external rectus; it passes forwards and outwards, lying on the levator palpebræ, which it grooves, and beneath the periosteum, and about one inch behind the margin of the orbit, becomes flattened, and divides into two branches—an internal or supratrochleator, and an external or proper frontal, or supraorbital; the former runs forwards and inwards, passes above the trochlea of the superior oblique muscle, where it sends down a branch to communicate with the infratrochleator; it then pierces the superior palpebral ligament, escapes beneath the lower margin of the corrugator supercilii, and, perforating the internal fibres of the orbicularis palpebra-

rum, divides into two sets of branches—superior, which pass upwards and inwards to supply the integuments of the centre of the forehead, orbicularis, and occipito-frontalis muscles; and an inferior, which divides into palpebral and nasal filaments; the one supplying the upper lid, and communicating with the lachrymal, and the other passing downwards and inwards, to be distributed to the integument on the side of the nose. The supratrochleator branch is sometimes very large, and in that case gives off a portion of the filaments which the proper frontal ought to have supplied. The proper frontal, or supraorbital, passes through the supraorbital notch, sending into the osseous diploe a small branch, which may be traced to the frontal sinus, then runs between the corrugator supercilii and the orbicularis palpebrarum, and afterwards curving upwards, divides into two branches—an external and internal; the former, the larger of the two, passes upwards and outwards between the occipito-frontalis and the periosteum, and divide into long and flat branches, which pierce the muscle, and are principally distributed to the integuments, very few being given either to the periosteum or muscle; while the latter or internal frontal, pierces the upper fibres of the orbicularis muscle, to be distributed to the integument, both it and the former sending their branches back as far as the lambdoid suture.

Nasal Nerve, intermediate in size between the lachrymal and frontal, enters the orbit through the base of the sphenoidal fissure between the two heads of the external rectus, and between the two divisions of the third; it next runs forwards and inwards, between the superior rectus above, and the optic nerve below, and reaches the inner wall of the orbit, where it lies above the internal rectus and below the superior oblique, and here divides into an external or infratrochleator, and an internal or proper nasal; the latter, apparently the continued trunk of the nerve, enters a groove leading to the anterior ethmoidal foramen, through which it passes, and enters the cavity of the cranium; it now crosses the cribriform plate, in a sulcus or groove, and descends, through the nasal slit at the side of the crista galli, into the upper part of the nose, where it divides into an internal and external branch; the former passes downwards and forwards between the mucous membrane and the bony septum, and can be traced even as low as the floor of the nose; while the latter, after giving off one filament to ramify on the anterior part of the external wall and the spongy bones, runs on the posterior surface of the nasal bones in an osseous groove, through which it sends filaments to the skin (Wenzel), and continuing its course, pierces the fibrous tissue, which unites the lateral cartilage to the bone, and becoming cutaneous, expands into fan-like branches on the side of the nasal ala. The external or infratrochleator branch passes forwards beneath the pulley of the supe-

rior oblique, pierces the inferior palpebral ligament, sending branches through the fibrous covering of the lachrymal sac, to supply it as well as the nasal duct, and ultimately terminates in the lower lid, assisting with the subcutaneous malæ and a branch from the infra-orbital in forming the inferior tarsal arch.

Branches of the Nasal Nerve.—While in the anterior part of the cavernous sinus, the nasal nerve receives filaments from the sympathetic, or carotid plexus, and on entering the orbit gives off a twig of communication to the superior division of the third; after this, and while on the outer side of the optic nerve, it throws off the long root to the lenticular ganglion; but this will be examined hereafter, as well as the two long ciliary branches, which arise on the inner side of the optic nerve, as they appertain to the same system.

Lenticular or Ophthalmic Ganglion, is somewhat ovoid in shape, with the larger extremity situated posteriorly, placed on the external side of the optic nerve, and internal to the external rectus, and lying about three lines in front of the optic foramen, but behind and at some distance from the globe of the eye; it is always surrounded by a quantity of loose fatty tissue, that renders its dissection, under all circumstances, an operation of extreme difficulty, but in a very fat subject, almost an absolute impossibility. The surface turned towards the optic nerve is concave, whilst that on the outer side is convex, and it presents four angles—the posterior superior, receiving the long root from the nasal, and the posterior inferior, that from the inferior oblique division of the third; while from the anterior angles, both above and below, arise the short ciliary nerves. The ganglion consists of two very obvious constituents: at its posterior margin the two white filaments unite in a loop, the concavity of which is directed backwards, and from this loop short plexiform filaments pass forwards, involving in their areolæ, the granular ganglion cells which form it; so that while the posterior margin is white, the anterior or greater portion is grey; but it does not seem that the existence of ganglionic cells is essential to the function of the ciliary branches emanating from the ganglion, as we have often observed the formative branches coalescing to form a loop, without the presence of a ganglion or its elements, whilst from a careful examination of the iris, we could not detect any anatomical character indicating inefficiency of function during life. The ciliary branches which arise from the anterior angles of the ganglion, are divisible into a superior and inferior fasciculus, the former consisting of from four to six, and the latter of from six to ten filaments; these pass forwards tortuously around the optic nerve, which they leave on reaching the globe of the eye, and, turning directly forwards, pierce the sclerotic at its posterior third, and then running between it and the choroid, perforate

the ciliary ligament, in which some of them remain, while the larger number emerge from its inner circle, to terminate in the iris. Tiedemann believes that the ciliary arteries are accompanied by branches of the lenticular ganglion, the former, in fact, conducting them to the retina; and also states, that he has seen a filament perforate the optic nerve with the arteria centralis retinæ; but the existence of the filament, described as arising from the Casserian ganglion, and joining the inferior root of the lenticular ganglion, wants confirmation.

NASO-CILIARY NERVES are two, sometimes three, or even four slender filaments, which arise from the nasal nerve, on the internal side of the optic, and after communicating with the other ciliary branches, run on each side of the optic nerve, having a similar termination to those before mentioned. These nerves have been sometimes termed "long ciliary," without any obvious reason or advantage.

SUPERIOR MAXILLARY, or SECOND DIVISION of the FIFTH, arises in common with the ophthalmic, from the anterior and external part of the ganglion, and runs almost horizontally forwards, to reach the foramen rotundum, through which it passes into the pterygo-maxillary fossa; it now curves forwards, along the superior wall of that fossa, with its concavity directed upwards and forwards, and enters the infra-orbital canal, through which it runs forwards and downwards, until at length it emerges by the infraorbital foramen to terminate on the face. This nerve is commonly overlapped at its origin by the ophthalmic, and in the remainder of its course within the skull, which does not exceed half an inch, lies close to the bone, being only separated from it, by a thin layer of dura mater; it is at first a little flattened, but as it passes through the foramen rotundum, it becomes cylindrical and constricted by the margins of that aperture; in the pterygo-maxillary fossa, it loses the filamentous character which it possessed while within the cranium, and becomes white and fasciculated, being here easily torn into bands, often of a pearly whiteness. As it lies in this bony fossa, the internal maxillary artery is on its outer side, and the vertical plate of the palate on its internal; but on entering the infra-orbital canal, it generally lies on the infra-orbital artery; it now escapes through the foramen of that name, between the outer head of the levator labii superioris alæque nasi, and the levator anguli oris, and divides into palpebral, nasal, and labial branches: the first, or the palpebral, pass upwards, supplying the integument and conjunctiva of the lower lid, communicating externally, with the malar branch of the lachrymal, and internally, with the infra-trochleator of the nasal; the second, or nasal, run on the side and dorsum of the nose, supplying the integument, and communicating with the nasal of the ophthalmic;

while the third, or labial, which are very numerous, run downwards and inwards to the upper lip, supplying the integument of that region, and there communicating with the facial nerve.

Collateral Branches of Superior Maxillary.—1. Ganglionic; 2. Superior dental; 3. Orbital; 4. Infra-orbital; 5. Anterior dental.

GANGLIONIC, consist of two branches, which descend from the inferior surface of the nerve, and being joined by filaments from the sympathetic, form Meckel's ganglion, which is an oval swelling of a grey colour, lying on the outer side of the ascending plate of the palate bone, at the superior part of the pterygo-maxillary fossa, and on the internal side of the internal maxillary artery, in its third stage; occasionally this ganglion is absent, when branches derived from the superior maxillary take the place of those which ought to have arisen from the ganglion—these branches being an inferior or posterior palatine, an internal or spheno-palatine, and a posterior or Vidian.

The *Inferior or Posterior* PALATINE NERVES, are three in number, namely, anterior, middle, and posterior. *The first, or great palatine,* descends in the posterior or pterygo-palatine canal, and emerging on the soft palate inferiorly, passes forwards, dividing into an external and internal branch; the former, running internal to the alveolar process in a groove as far as the incisive foramen, where it joins Cloquet's ganglion; while the latter, proceeds to the centre of the soft palate, where it is distributed to the mucous membrane and palatine glands. During the course of the trunk through the posterior palatine canal, it sends branches forwards through the bone (long nasal) to ramify on the pituitary membrane, covering the middle and inferior spongy bones; as well as several small twigs that pierce the inner wall of the maxillary sinus, and supply the molar teeth.

Middle Palatine Branch.—Smaller than the last; descends through a special canal in the pterygoid process of the palate bone, and emerging inferiorly, is distributed on the nasal surface of the soft palate.

Posterior Palatine Branch.—An exceedingly slender twig, often absent; pierces the pterygoid process of the palate bone, by a small foramen, and is lost in the soft palate and uvula.

INTERNAL, or SPHENO-PALATINE, arises from the internal surface of Meckel's ganglion, and consists of two branches, an external and internal, both passing into the nose by the spheno-palatine foramen; the former, on entering the cavity, runs along the superior meatus and spongy bone, supplying the pituitary membrane of these parts, and sometimes giving off a pharyngeal branch, which is distributed to the superior part of the pharynx; while the latter, or internal,

sometimes called the naso-palatine, or nerve of Cotunnius, passes inwards, crossing the inferior and anterior part of the side of the body of the sphenoid bone, reaches the septum, and running downwards and forwards, enters the anterior palatine canal, where it joins the superior part of Cloquet's ganglion, the internal palatine being connected with its inferior extremity. Cloquet's ganglion may be exposed by sawing a wedge-shaped piece from the symphysis of the superior maxillary bones, and, when this is done, a fusiform mass is seen, occupying the foramen incisivum, its principal bulk being composed of dense periosteum, on the removal of which, some fatty areolar tissue appears, and on unravelling this web, a communication is observed between the naso-palatine, and the palatine nerves. We have also sometimes observed a slight enlargement with a grey tinge, at the point of union, but by no means constantly. This ganglion is described as being large in the graminivora, and especially in the horse, in which it receives a branch from the olfactory. Cruveilhier describes the naso-palatine nerve, as passing through the bone to that portion of the palate behind the incisor teeth; and believes, with Arnold, that Cloquet's ganglion has no existence, but in this opinion we find ourselves unable to coincide.

Vidian Nerve, pursues an exceedingly long course, being first without the cranium, then within that cavity; then in the tympanum, or middle ear; and lastly, without the cranial cavity again. It arises from the posterior part of Meckel's ganglion, and passing outwards and backwards through the pterygoid canal, pierces the cartilage which closes the foramen lacerum anterius in basi cranii between the Eustachian tube and the carotid artery; here it divides into an inferior or carotid branch, and a superior or cranial; the former, the larger of the two, passes upwards in the carotid canal, and anastomoses with the sixth, small petrosal, and sympathetic branches, to form the carotid plexus; while the latter, or the great petrosal branch, runs backwards in a groove, beneath the Casserian ganglion, on the upper surface of the petrous portion of the temporal bone, invested by dura mater, and accompanied in its course by a branch of the middle meningeal artery; it then enters the hiatus Fallopii, which leads into the aqueduct of Fallopius, in which it passes downwards, backwards, and outwards, and having communicated with the intumescentia gangliformis of the portio dura, it pierces the posterior wall of the tympanum; and, running downwards through that cavity, between the long crus of the incus, and the manubrium of the malleus, it escapes through an aperture internal to the Glaserian fissure; it now unites with the gustatory nerve, from which it cannot be separated, and having accompanied it, as far as the posterior edge of the hyo-glossus muscle, suddenly

leaves it, to terminate by forming the submaxillary ganglion, some anatomists having succeeded in tracing a branch to the lingualis muscle.

SUBMAXILLARY GANGLION.—A small oval body, of a pinkish grey colour, situated on the posterior edge of the hyo-glossus muscle ; in addition to the Vidian, two filaments likewise descend from the gustatory to join its posterior angle ; while again, two others, arising from the anterior angle, seem to ascend, to join the gustatory. Farther on, a number of sympathetic twigs, conveyed to the gland by the facial artery, also enter into its formation ; and we have seen a filament from the mylo-hyoid branch of the inferior dental, also joining it, in one instance. There is some doubt as to whether the chorda tympani really enters the ganglion, as a branch of the superior maxillary ; many authorities are disposed to believe that the Vidian actually terminates in the portio dura, and assert that the formative branch to the ganglion, is a distinct branch of the latter, which accompanies the gustatory, into the submaxillary gland, to preside over the rhythmic motions of its ducts, and afterwards continuing its course to the lingualis muscle, constitutes its motor nerve. Precisely the same remark may be applied to the Vidian, in the anterior part of its course; and we have always been inclined to consider it also as a branch from the portio dura to Meckel's ganglion, and not as one from the ganglion to the nerve.

The ORBITAL BRANCH OF THE SUPERIOR MAXILLARY, enters the orbit through the spheno-maxillary fissure, and passing upwards and forwards, between the outer wall of that cavity and the periosteum, anastomoses with the lachrymal, and then divides into a temporal and a malar branch ; the former, escaping through the orbital plate of the malar bone, passes through the temporal muscle and fascia, and becoming superficial, terminates in the integument of the temporal region, where it communicates with the portio dura, and the temporo-auricular nerves ; while the latter pierces the same bone, and is distributed to the integuments of the cheek.

SUPERIOR DENTAL BRANCHES OF THE SUPERIOR MAXILLARY, are two in number—superior and inferior—which arise from the nerve just before it enters the infra-orbital canal, after having first sent a few branches to the buccinator, and fat in the vicinity ; they enter proper canals in the bone, and passing forwards, the superior communicates with the anterior dental, and the inferior with that above it, close to the canine fossa. From their inferior surface a number of branches arise, which in the diploe form an intricate interlacement, from which filaments are sent into the neutral apertures, to the fangs of the molar and bicuspid teeth ; but it does not appear that all the plexus is consumed by the dental branches, as many filaments are lost on the diploic cancellous walls of the bone itself.

Anterior Dental of the Superior Maxillary.—An exceedingly large branch, arising from the infra-orbital, near the facial extremity of the canal, enters a special channel, passing at first inwards, then downwards, but separated from the antrum and its lining membrane, by a thin osseous plate ; having arrived at the root of the nasal process, it divides into a number of branches, some of which remain in the bone, while the greater number supply the incisor, canine, and first bicuspid teeth ; from the outer side of the trunk, a small filament passes, to communicate with the posterior superior dental branch.

Inferior Maxillary Nerve, or Third Division of the Fifth, of which it is the largest branch, arises from the posterior inferior angle of the ganglion, then passes downwards, forwards, and outwards, and, escaping from the cranium by the foramen ovale, reaches the zygomatic fossa. In the first part of its course, the hard root of the fifth lies beneath it, at the foramen ovale posterior to it, and in the fossa first external and anterior to it, and then winding round it, they become intimately united ; but prior to this union, they can easily be distinguished, one being grey and plexiform, and the other white and distinctly fibrous. While in the zygomatic fossa, the inferior maxillary nerve has the following relations :—Anteriorly, the posterior edge of the internal pterygoid, and the tensor palati muscles; posteriorly, the middle meningeal artery, and origin of the internal lateral ligament of the lower jaw ; externally, the external pterygoid ; and internally, the otic ganglion, and the Eustachian tube. Immediately after the union of the two roots, it divides into two sets of branches—external and internal, or motor and sensific—the former, being the deep temporal, buccal, masseteric, and pterygoid ; and the latter, the inferior dental, gustatory, and temporo-auricular.

Deep Temporal, consists of two branches, an anterior and posterior, which pass between the external pterygoid and the crest of the great wing of the sphenoid bone, and after communicating with branches from the buccal and masseteric nerves, ascend, one on the anterior, and the other on the posterior part of the temporal fossa, beneath the temporal muscle, in which they terminate, a branch being sent through the muscle and fascia, to communicate with the temporo-auricular in the integument, while filaments are also detached deeply, to join the temporal branches of the superior maxillary, and lachrymal.

Buccal Branch.—May be either single, or consist of two or three roots, which, piercing the external pterygoid, unite into a single trunk, that passes forwards, between the temporal tendon and the external pterygoid, giving off twigs to both those muscles, and, having arrived at the posterior margin of the buccinator, divides into

numerous branches, some of which supply the skin and communicate with the portio dura, but the greater number, piercing the muscle, are ultimately lost in the mucous membrane.

Masseteric Branch.—Smaller than the last; passes outwards, piercing the superior attachment of the external pterygoid, and having given off a twig to the periosteum of the temporal fossa, escapes through the sigmoid notch of the lower jaw, in front of the articulation, to which it sends a filament, and behind the coronoid process and insertion of the temporal; it then divides into branches, which descend in the deep fibres of the masseter, as low as the angle of the jaw.

Pterygoid Branches, usually consist of three or four short filaments, and one long branch; two of the former enter the external pterygoid, while one enters the internal; but the latter, much larger and longer, arising from the inferior maxillary, in the immediate vicinity of the otic ganglion, courses along the inner surface of the muscle, and unites with the lesser petrosal.

Otic, or Arnold's, Ganglion.—This small nervous centre may either be dissected from within, by removing the petro-pharyngeal aponeurosis and Eustachian tube, or, having turned outwards the external pterygoid, the inferior maxillary nerve should be cut across. when it will be found on its inner side. The ganglion is small and grey, like the ophthalmic, and possesses three roots, one short, from the internal pterygoid branch of the inferior maxillary; the second long, being the nervous petrosus superficialis minor, derived from the tympanic plexus; while the third is grey and soft, and comes off from the sympathetic, as it surrounds the middle meningeal artery. Its relations are the following:—Externally, the inferior maxillary nerve, before it gives off its external branches; internally, the Eustachian tube; anteriorly, the tensor palati, and the posterior edge of the internal pterygoid muscle; and posteriorly, the middle meningeal artery, and a nervous plexus which surrounds that vessel. Its branches are four in number, one being to the tensor tympani, a second to the tensor palati, a third to the Eustachian tube, and a fourth to communicate with the temporo-auricular branch.

The absence of this ganglion has been noticed by many anatomists, but we have invariably found it present, yet with some variety as to the origin of its short root, which has sometimes sprung from the trunk of the inferior maxillary, instead of from its internal pterygoid branch.

Temporo-auricular Branch.—The smallest of the three internal divisions of the inferior maxillary nerve, arises from its outer and back part, near the base of the skull, and passes backwards and outwards, between the Eustachian tube and the external pterygoid mus-

cle; it soon divides into two branches, which surround the middle meningeal artery, when they again unite into a single nerve, which runs between the internal lateral ligament and the neck of the lower jaw, and divides into a superior and inferior branch; the former winds round the posterior part of the superficial temporal artery, so as to become superficial to it, and ascending in company with it to the temporal region, terminates in the integument; during its course it gives off a branch to communicate with the portio dura, as well as filaments to the temporo-maxillary articulation; the inferior branch passes downwards, and forms a plexus on the internal maxillary artery, the filaments that compose it presenting ganglionic enlargements at intervals, and sending twigs to the parotid, lobe of the ear, temporo-maxillary articulation, and a branch of communication to the auricularis magnus.

Inferior Dental.—Larger than the gustatory, with which it arises in common; it descends between the two pterygoid muscles, then passes downwards and outwards, between the internal lateral ligament and ramus of the jaw, enters the posterior orifice of the dental canal, and coursing through it beneath the molar teeth, arrives at the mental foramen, where it divides into two branches—one, the mental, which escapes through that aperture, and passing between the triangularis oris and quadratus menti, divides into a number of diverging filaments, some of which pierce the quadratus, and are distributed to the mucous membrane of the lower lip; while others remaining superficial, are lost in the integument, and communicate with the portio dura; the continuation of the trunk, extremely small, passes beneath the incisor teeth (incisor branch), and terminates at the symphysis menti. The dental nerve, during its whole course, gives off filaments which enter the foramina in the fangs of both molar, canine, and incisor teeth, to terminate in the dentinal pulp; and, in addition to the mental, this nerve likewise gives off twigs to the pterygoid muscles, also a branch of communication to the gustatory, and just as it is about to enter the dental canal it throws off its *Myloid* branch.

Myloid Branch, enters a groove in the ramus of the lower jaw, in which it is bound down by a process of the internal lateral ligament, and emerging from beneath the anterior edge of the internal pterygoid, strikes the posterior margin of the mylo-hyoid, which it supplies on its upper surface, as well as the genio-hyoid; while a branch running on the lower aspect of that muscle, sends filaments to the anterior belly of the digastric, and a few others which wind over the symphysis, to the quadratus menti. This nerve, although apparently an offset from the dental, is clearly not so, as its function distinctly shows it to be a direct deviation from the hard root of the fifth.

Gustatory Nerve.—Smaller than the last, and on arising from the inferior maxillary, lies at first between the external pterygoid, and the pterygo-pharyngeal aponeurosis, then passes downwards between the two pterygoids, and here receives the chorda tympani, next runs between the ramus of the jaw and internal pterygoid, and escaping from beneath the anterior edge of that muscle, lies on the mylo-hyoid attachment of the superior constrictor, and above the submaxillary gland; still pursuing its course forwards and upwards, accompanied by the Whartonian duct, which it crosses at an acute angle, and lying on the hyo-glossus, and mucous membrane of the mouth, and above the sublingual gland and mylo-hyoid muscles, it reaches the inferior surface of the tongue, when it divides into long and slender filaments, that pierce the inferior lingualis and stylo-glossus, and its ultimate twigs may be traced to the simple papillæ on the dorsum and tip of the tongue, where they terminate in loops. The gustatory nerve receives, in the pterygoid space, a constant branch of communication from the inferior dental, and a little lower down the chorda tympani, which is inseparably united with it; it also gives off the formative branches to the submaxillary ganglion, as well as twigs to the tonsil, half arches of the palate, and mucous membrane of the fauces, and while on the hyo-glossus, a number of filaments join the lingual or hypo-glossal nerve to form the hyo-glossal plexus, which rests on the hyo-glossus muscle. The sense of taste, resides in those parts supplied by the gustatory nerve.

Sixth Nerve, or Abducens, intermediate in size between the third and fourth, arises from the pyramidal body, just as it joins the pons Varolii; it passes upwards, forwards, and outwards, between the pons and the basilar process of the occipital bone, separated from its fellow by the basilar artery; it then perforates the dura mater about a quarter of an inch below the posterior clinoid process, and passing over the suture between the petrous portion of the temporal, and the sphenoid bone, courses along the inner wall of the cavernous sinus, lying on the outer side of the carotid artery, and merely separated from the blood of the sinus by the venous membrane; but at the anterior part of the cavity, it passes outwards, lying immediately beneath the opthalmic division of the fifth, and above the opthalmic vein; it then runs through the base of the sphenoidal fissure, between the two heads of the external rectus, and attaches itself to the deep surface of that muscle, which it supplies exclusively. While in the cavernous sinus, it communicates with the sympathetic and Vidian nerves, by very fine filaments which lie on the outer side of the carotid artery.

Seventh Nerve, consists of two portions—*portio mollis*, and *portio dura*, or facial nerve. The *portio mollis*, large, grey, and flattened,

arises from the side of the calamus scriptorius, by four or five banded filaments, which unite and pass upwards, forwards, and outwards, in front of the pneumogastric and subpeduncular lobule, becoming visible behind the crus cerebelli; while the *portio dura*, white, round, and fasciculated, appears to rise in a depression, bounded behind by the restiform, in front by the pyramidal, above by the pons, and below by the olivary body, and winding forwards from this point beneath the crus cerebelli, becomes applied to the portio mollis. In their course outwards and forwards, to reach the external auditory meatus, they are separated from each other by the restiform body, choroid plexus of the fourth ventricle, and the acoustic artery, a branch of the superior cerebellar; but as they proceed, their relation to each other becomes altered, as the dura which at first lay anterior to the mollis, on entering the auditory meatus, becomes superior to it; while in the canal, they are connected by a branch of communication (portio intermedia, Wrisberg), but at the extremity of the meatus they separate from each other altogether; and each should now be followed independently to its termination.

Auditory, Terminal Distribution.—On reaching the extremity of the internal auditory meatus, this nerve divides into the vestibular, and cochlear branches; the former, which is the more posterior, consists of three sets of branches—superior, middle, and inferior: the first pierces the inner wall of the vestibule, immediately behind the internal orifice of the aqueduct of Fallopius, and is distributed to the utriculus and the ampullæ of the vertical and horizontal semicircular canals; the second supplies the saccule; and the third, which is the smallest, is distributed to the ampulla of the oblique semicircular canal. The latter, or cochlear nerve, pierces the infundibuliform canal at the inner extremity of the modiolus, giving off lateral branches which perforate, in a spiral manner, the walls of the canal, and are distributed to the lamina spiralis. The portio mollis is extremely soft, and its neurilemma is so fine that the trunk is easily divided into fascicles, with a remarkable tendency to become varicose, in fact, seeming to be a continuation of the substance of the brain itself. As to its ultimate distribution, much difference of opinion prevails, analogy appearing to imply a looped arrangement, but observation has determined a primary plexiform interlacement with ultimate free points. (*Todd and Bowman*, pp. 83, 84.)

Course and Termination of the Portio Dura.—At the inner extremity of the auditory meatus, the nerve enters the aquæductus Fallopii, passes at first outwards, and then bending backwards, runs through the substance of the inner wall of the tympanum, superior to the fenestra ovalis; it then turns downwards, and escapes by the stylo-mastoid foramen, presenting, while within the canal, at the

posterior wall of the tympanum, an enlargement (intumescentia gangliformis), with which the Vidian nerve is connected, and receiving immediately, previous to its escape from the bone, a communicating branch from the pneumogastric (auricular nerve of Arnold). After its emergence from the stylo-mastoid foramen, it passes forwards, in the substance of the parotid gland, for about half an inch, and then divides into temporo-facial and cervico-facial branches; and these, uniting frequently by cross branches, constitute the parotidean plexus, or pes anserinus.

Temporo-facial.—Exceedingly large, passes upwards and forwards, forming a concavity, which is directed upwards, and crossing the neck of the lower jaw, receives a branch of communication from the temporo-auricular nerve; it now divides into temporal, orbital, and infra-orbital, all of which frequently anastomose with each other, forming arches, with their convexities directed forwards. The temporal, crosses the zygomatic arch at right angles, expands on the temporal region, and communicates with the frontal and temporo-auricular nerves; its branches are flat like ribbons, some terminating in the skin, and others in the frontal portion of the occipito-frontalis. The orbital set, pass forwards beneath the upper and lower segments of the orbicularis palpebrarum, which they supply, together with the corrugator supercilii. The infra-orbital, consist generally of two sets, which accompany the Stenonian duct, across the masseter muscle—one set, superficial, supply the zygomatics, levator labii superioris, and pyramidalis nasi; the second, deeper, are distributed to the levator anguli oris and compressor nasi, while long slender twigs of both divisions are given off to the integument, and communicate with the infra-orbital of the superior maxillary.

Cervico-facial Division.—Smaller than the last, runs downwards and forwards in the substance of the parotid, and divides into buccal, mental, and cervical branches; the buccal, as they cross the masseter, frequently communicate, and having sent one or two filaments to that muscle, then run between the fibres of the buccinator, which they supply, while they communicate with the buccal branch of the inferior maxillary. The mental, pass forwards for the supply of the muscles of the lower lip, and anastomose with the mental branch of the inferior dental; while the cervical, run downwards and forwards and then curving upwards between the platysma and fascia, terminate beneath the chin in the submaxillary region, where they communicate with a superficial branch of the cervical plexus.

As the trunk of the portio dura leaves the stylo-mastoid foramen it gives off three small branches—the posterior auricular, stylo-hyoid, and digastric. The first, or the posterior auricular, arises from the external and posterior part of the trunk, winds round the anterior

and external face of the mastoid process, and then ascending, sends one branch backwards on the occipital region, while the other enters the retrahens aurem, and having given a twig to that muscle, passes upwards to reach the attollens aurem, in which it ultimately terminates. The stylo-hyoid branch, enters the upper border of that muscle and supplies it; while the digastric twig, piercing the posterior belly of that muscle, and having supplied it, then communicates with the glosso-pharyngeal.

The PORTIO DURA is destined for the supply of the superficial muscles of the face presiding over expression, and we conceive that the cutaneous branches, which in some cases are numerous, exercise a special influence in producing a corresponding movement of the skin when particular muscles are in action; this idea of course presupposing the existence of motive tissue, in the tegumentary structure. Sir Charles Bell named it the respiratory nerve of the face, in consequence of the peculiar condition of the features in lesions of the respiratory organs.

The EIGHTH PAIR of NERVES, consist each of three distinct portions, the glosso-pharyngeal, pneumogastric, and spinal accessory; of these the first is the smallest, the second the largest, and the third intermediate in size between the other two.

GLOSSO-PHARYNGEAL.—The highest of the three divisions of the eighth pair, arises by several filaments from the upper part of the groove between the olivary and restiform bodies, and running forwards and outwards, towards the foramen lacerum posterius, escapes through a distinct canal, in front of the jugular vein, and pneumogastric and spinal accessory nerves; it then runs outwards, between the former and internal carotid, and descending anterior to the latter vessel, and behind the styloid process and stylo-pharyngeus, it turns forwards and inwards, coursing along the lower edge of that muscle for some distance, and then curves around it, to reach a triangular space bounded above, by the stylo-glossus; below, by the stylo-pharyngeus; and in front, by the hyo-glossus; while its floor, is formed by the superior constrictor of the pharynx. In this situation, while it lies immediately behind the tonsil, and in front of the palato-pharyngeus, it divides into its ultimate branches—the glossal, and pharyngeal. In the upper part of the jugular fossa, it presents a small mass of grey matter, only involving a few of its fibres; this, which is named the petrosal ganglion of Müller, but which was really discovered by Ehrenritter, is of very little importance, as it gives off no branches whatever; but the jugular ganglion (Andersch), which is situated much lower down, in a depression in the petrous portion of the temporal bone, at the inner and anterior part of the jugular foramen, but still in the bone which forms the external boundary of

that opening, includes the whole trunk of the glosso-pharyngeal; not always, however, presenting the same size or colour, as we have seen the nerve at this point only exhibiting a slight grey tinge, without the appearance of any ganglion whatever; but this occurred only in a few solitary instances. The branches given off by the glosso-pharyngeal are—tympanic, muscular, vascular, tonsillary, pharyngeal, and lingual.

Tympanic Nerve of Jacobson, arises from the ganglion of Andersch, and enters a small canal, or sometimes a fissure on the crest of bone which separates the carotid and jugular openings, to reach the promontory on the inner wall of the tympanum, where it divides into three short and three long branches, the former being thus distributed:—one, to the fenestra ovalis; the second, to the fenestra rotunda; and the third, to the Eustachian tube; while the latter are arranged in the following manner:—one, passes forwards through the bone to join the carotid plexus in the canal of that name; the second, runs upwards and forwards, to communicate with the Vidian, in the aqueduct of Fallopius; and the third, which is called the nervus petrosus superficialis minor, passes upwards through a minute canal, and emerges on the upper surface of the petrous portion of the temporal bone, external to the orifice for the Vidian nerve, and then leaves the cranium in either of the three following ways, namely, by the foramen spinosum, or by the foramen ovale, or by a fissure between the posterior extremity of the spine of the sphenoid and the petrous portion of the temporal bone, and then joins the otic ganglion as its long root. The three long branches, while within the tympanum, lie in canals on the promontory, or sometimes merely in grooves, and act as the agents in establishing several important communications between other nerves, as through them the glosso-pharyngeal is brought into relation with the sympathetic, fifth pair, and Vidian nerves.

The branch of communication to the facial nerve, also arises from the same ganglion; it passes downwards and outwards, behind the styloid process, then curves upwards and forwards, and joins the facial nerve just as it emerges from the stylo-mastoid foramen; communicating branches also unite the glosso-pharyngeal with the pneumogastric, and the spinal accessory, the three nerves sometimes appearing to be completely incorporated with each other.

Muscular Branches, are two in number, one being sent to the posterior belly of the digastric; and the other, subdividing to the stylo-hyoid and stylo-pharyngeus.

Vascular Branches, are exceedingly small, but very numerous; they run downwards on the carotid and jugular vein, and communicate with branches of the superior-cervical ganglion of the sympathetic.

Branches to the Tonsil, pierce the superior constrictor, and in the gland form a plexus with filaments from the gustatory and palatine nerves.

Branches to the Pharynx, consist of three or four flat filaments, which pass in front of the internal carotid artery, and curve a little upwards and forwards, to join the superior angle of the pharyngeal plexus.

Terminal Branches to the Tongue.—The trunk of the nerve, having passed beneath the hyo-glossus, appears much diminished in size, and divides into a number of slender branches, which ramify in the submucous tissue at the base of the tongue, and terminate by supplying the mucous membrane of both the posterior part and margins; two long filaments have likewise been described as running forwards, along its median septum to its tip, but after repeated examinations, we are strongly inclined to believe that the course is rarely uniform, and their existence as frequently questionable. According to the experiments of Dr. Reid, the function of this nerve is purely afferent or sensitive, and although essential to the gustative sense, should not be regarded as the proper nerve of taste, as Magendie endeavoured to prove.

PNEUMOGASTRIC, the largest of the three branches of the eighth, arises also from the groove between the olivary and restiform bodies immediately beneath the last, and passes forwards and outwards, to reach the foramen lacerum posterius, through which it emerges in front of the internal jugular vein, behind the hypo-glossal nerve, and in company with the spinal accessory; passing now downwards, backwards, and inwards, it insinuates itself between the internal carotid and jugular vein, so as to lie behind and between them, and having descended in the sheath, as far as the root of the neck, it enters the thorax, crossing on the right side in front of the subclavian artery, and behind the right vena innominata, at a right angle to the former: the space which it here traverses, is in figure that of an isosceles triangle, formed by the divarication of the two principal constituents of the sheath, the carotid bounding it internally, the jugular vein externally, and the subclavian artery below; but on the left side, it passes parallel, yet anterior and internal to the corresponding subclavian, and behind the left vena innominata. The right nerve, on entering the thorax, runs backwards and inwards, through a quadrilateral vascular space, bounded externally, by the right vena innominata; internally, by the arteria innominata; below, by the left vena innominata; and above, by the subclavian artery; and then descends on the posterior and right side of the superior cava, until it reaches the posterior part of the root of the lung, by passing between the curve of the vena azygos, and right bronchial tube; while the left

nerve, crosses the junction of the transverse and descending portions of the arch of the aorta, posterior and external to the corresponding phrenic, which here crosses it, and attains the root of the left lung by passing between the ductus arteriosus, and left pulmonary artery; both trunks now enter the posterior mediastinum, the left lying on the anterior and left side of the œsophagus; and the right on the posterior and right side of the same tube, and, following its course, they pass through the œsophageal orifice in the diaphragm, and terminate on the stomach. From the foregoing account, it will be seen that these nerves may be divided into four stages—firstly, cranial; secondly, cervical; thirdly, thoracic; and fourthly, abdominal; and the student may now proceed to examine the branches arising in each, which may be thus enumerated:—

Cranial Branches,—communicating and auricular nerves of Arnold.

Cervical Branches,—communicating, pharyngeal, superior laryngeal, cardiac, and right inferior laryngeal.

Thoracic Branches,—left inferior laryngeal, pulmonary, and œsophageal.

Abdominal Branches,—gastric or terminal branches to stomach, &c.

Communicating Branch.—While within the jugular foramen, the pneumogastric exhibits a grey or ganglionic structure, but usually without any well-marked enlargement; and from this a fine, slender branch comes off, which joins the ganglion of Andersch, on the glosso-pharyngeal.

Auricular Nerve of Arnold, likewise springs from the same ganglion, and passing backwards and outwards, enters a canal at the posterior and external part of the jugular fossa, through which it reaches the stylo-mastoid hole, where it anastomoses with the portio dura, having previously given an anastomotic twig to the nerve of Jacobsen; it now emerges from the stylo-mastoid foramen, and divides into three small branches, one of which joins the facial, the second communicates with the posterior auricular of the same nerve, and a third, passing over the crest of bone, uniting the vaginal and auditory processes, which often presents a groove in this situation, terminates on the cartilage of the ear.

Pharyngeal Nerve.—A small branch, sometimes double, arises from the pneumogastric, about a quarter of an inch below the base of the skull, and passing downwards and inwards, reinforced in its course by filaments from the glosso-pharyngeal and sympathetic, joins the pharyngeal plexus. At the point where the pharyngeal nerves arise, or about a quarter of an inch below the base of the cranium, the pneumogastric always presents a well marked ganglionic swelling of a pinkish gray colour, and varying in length according to the subject in which it may be examined, from half an inch

to two inches and a half. This ganglion was described both by Cooper and Müller, and is indifferently called after either author.

Pharyngeal Plexus.—Triangular in figure, with the base in front corresponding to the superior and middle constrictors, and the apex posteriorly between the two carotids, is formed by the pharyngeal branch of the pneumogastric, and by a branch from the superior laryngeal and glosso-pharyngeal, with many grey filaments from the superior cervical ganglion of the sympathetic ; it is also stated that it receives twigs from the spinal accessory, but this requires confirmation. Its branches, after frequent intercommunications, are distributed to the superior and middle constrictors, as well as to the mucous membrane of the pharynx. Of this plexus the superior laryngeal and glosso-pharyngeal are afferent, while the pharyngeal branch of the pneumogastric is efferent or motor, and it is very probable that the latter derives this function from the communicating branch of the spinal accessory.

Superior Laryngeal, rather small in size, arises from the pneumogastric ganglion below the pharyngeal, and passes downwards, forwards, and inwards, lying on the superior cervical ganglion of the sympathetic, ascending pharyngeal artery, rectus capitis anticus major, and on the descending fibres of the stylo-pharyngeus muscle, while it is covered by the internal and external carotids, and lingual and superior thyroid arteries ; while behind the internal carotid, it divides into two branches, an external and an internal ; of these, the former runs downwards and inwards, sending a filament to the pharyngeal plexus ; a second to the thyroid body, and a third to the inferior constrictor ; it then continues its course, passing beneath the thyroid body, and lying between the inferior constrictor and the ala of the thyroid cartilage, and terminates in the crico-thyroid muscle. In one case only, we observed that this branch ran between the inferior and middle constrictors, then beneath the ala of the thyroid cartilage, and ultimately turned forwards between the thyroid cartilage and the cricoid, sinking into the deep surface of the crico-thyroid muscle. The internal branch, or proper laryngeal nerve, generally enters the larynx by an aperture in the thyro-hyoid membrane, or again, it may occasionally run through the thyroid cartilage, and, having passed into its cavity, divides into ascending filaments, which ramify on the epiglottis and base of the tongue, and descending, some of which terminate in the aryteno-epiglottidean folds of mucous membrane ; others enter the proper arytenoid muscles, while a third set passes downwards, internal to the thyro and crico-arytenoid muscles, to communicate with the inferior laryngeal behind the crico-thyroid articulation. The function of this nerve is purely sensific.

Cardiac Branches, arise from the nerve at the inferior third of the neck—two being usually found on the left side, and one on the right; the former cross the left carotid, communicating with the cardiac branches of the sympathetic; while the latter runs over the right subclavian artery, and the arteria innominata, and assists in forming the great cardiac plexus.

Recurrent Laryngeal Nerves, arise at different points on the right, and left sides; in the one instance, curving round the right subclavian artery, and in the other, round the ductus arteriosus and arch of the aorta. The right, as it winds upwards, usually surrounds about one-third of the subclavian artery in its first stage; or should it take its origin a little higher, may inclose fully three-fourths of that vessel; it then passes upwards and inwards, behind the subclavian and carotid arteries, as well as the inferior thyroid, and lateral lobe of the thyroid body, and in front of the longus colli, until it reaches the groove between the trachea and œsophagus, where overlapped by the inferior constrictor, it continues to ascend, behind the crico-thyroid articulation; it sends one branch to the posterior crico-arytenoid, two slender filaments to the lateral crico-arytenoid, and thyro-arytenoid; and then divides into two branches —one of which ascends, to anastomose with a descending twig of the superior laryngeal; while the other running upwards and backwards, terminates in the proper arytenoid, and communicates likewise with the superior laryngeal branch. The left laryngeal, having curved round the ductus arteriosus, ascends behind the transverse portion of the arch of the aorta, and rests directly on the œsophagus; its termination is precisely similar to that of the right. The right laryngeal recurrent, may sometimes arise opposite the cricoid cartilage, and in that case, hooks round the inferior thyroid artery, instead of the subclavian. The cause of this peculiarity was pointed out by the late Dr. Hart, Professor of Anatomy in the College of Surgeons, who, having observed that it was connected with the anomalous origin of the right subclavian artery from the descending portion of the arch of the aorta, proposed the following solution of the question :—"In the earlier periods of fœtal existence, the brain is situated in front of the thymus gland and aorta. The larynx is placed at this time behind the ascending aorta. Hence it is that the inferior laryngeal nerves pass back to the larynx, separated by the aorta, the left going through its arch, while the right goes below the arterior innominata." Now, if the right subclavian arises on the left side, it is obvious that the right recurrent cannot possibly wind around it, and it as naturally takes advantage of its own satellite artery, to accompany it to their common destination.

During their course, the inferior laryngeal nerves distribute

branches to the cardiac plexus, rings of the trachea, and inferior constrictor. With respect, however, to their function, it would appear from the observations of Mr. Hilton, of Guy's Hospital, that it is purely motor; a fact capable of being proved by actual experiment; for when the pneumogastrics are divided above the origin of the inferior laryngeal, paralysis of the dilators of the glottis ensues, and the arytenoid cartilages fall into the glottis, producing asphyxia, which is rendered more rapid by the immature age of the animal, and the struggles attendant on the experiment. Pathology has also thrown light on this subject, as it appears that, when the recurrent has been subjected to the long-continued pressure of an aneurismal tumour, atrophy of the laryngeal muscles corresponding to the affected side ensues. (See Dr. Banks's Clinical Reports, in the *Dublin Quarterly Journal* for August, 1851, page 75; also, an account of Dr. Hugh Ferguson's Preparation, by Doctor R. W. Smith, *Dublin Quarterly Journal*, N.S., vol. ix. page 236.)

Pulmonary Branches, have been already examined with the lungs; (see ANATOMY of the CHEST).

Œsophageal Plexus, is formed by the union of a number of filaments, which arise from the pneumogastric trunks as they lie on the œsophagus, and completely surround it.

Gastric Branches.—When the pneumogastric nerves enter the abdomen, through the œsophageal opening, the left, which is anterior, expands on the anterior surface and lesser curvature of the stomach, sending branches, through the gastro-hepatic omentum, to the liver: while the right, which is posterior, spreads out on the posterior aspect and great curvature, supplying a number of branches to the solar plexus, pancreas, and spleen. The function of the gastric branches has given rise to much difference of opinion among physiologists. Wilson Philip believed them to preside over the secretion of gastric juice, and endeavoured to show that this function was suspended on their division in a living animal; Sir B. Brodie, on the other hand, conceives that their section checks the secretion of gastric mucus; while Dr. Reid considers that their division only impedes digestion, and that in a more marked degree in the herbivora, owing to the complexity of the function of digestion in that class of animals; and he leans to the opinion that they preside over the sensations of hunger and satiety, as emanating from the stomach, when deprived of its ordinary supply of nutrition.

SPINAL ACCESSORY NERVE.—Intermediate in size between the pneumogastric and glosso-pharyngeal, arises from the medulla spinalis, generally as low down as the fourth, but sometimes as low as the sixth cervical vertebra, between the posterior roots of the spinal nerves behind, and the attachments of the ligamentum denticulatum

in front; it passes upwards, through the foramen magnum, along the border of which it winds forwards, but separated from the vertebral artery by the first tooth of the ligamentum denticulatum; it then escapes through the jugular foramen, and, divides into an internal or anastomotic branch, which joins the pneumogastric; and an external, which after communicating with the glosso-pharyngeal, ninth and sympathetic nerves, passes downwards and outwards, lying in front of (sometimes behind) the jugular vein, and covered by the occipital artery; it next lies on the rectus capitis lateralis, beneath the posterior belly of the digastric; then pierces the upper third of the sterno-mastoid, and as it crosses the posterior superior triangle of the neck, communicates with the third and fourth cervical nerves; arriving now at the anterior margin of the trapezius, it divides into two branches, one of which ascends, to supply the cervical portion of that muscle, whilst the second descends, and is distributed to its dorsal division. Occasionally the nerve passes beneath the sterno-mastoid, without piercing its fibres, but always sends one or two small filaments to it. The function of this nerve, was believed by Sir C. Bell to be respiratory; while Bischoff regards it as merely the anterior root of the pneumogastric, both in fact being the analogues of the anterior and posterior divisions of a spinal nerve.

Lingual, or Ninth Nerve, arises by six or eight small filaments from the groove between the pyramidal and olivary bodies; these filaments of origin are sometimes collected into two roots, with the vertebral artery coursing upwards between them, and having united, form a single trunk which passes outwards and forwards, and escapes from the cranium by the anterior condyloid foramen; it then runs outwards, between the carotid artery and jugular vein, and having communicated with the eighth, sympathetic, and first and second cervical nerves, it descends for some distance, when it alters its course, and hooking round the occipital, or occasionally the sterno-mastoid branch of the external carotid, it runs downwards, forwards, and inwards, parallel but inferior to the posterior belly of the digastric, and crosses both carotids and the facial arteries; winding next above the tendon of the digastric, it glides between the mylohyoid and the hyo-glossus muscles, the latter separating it from the lingual artery; and at the anterior edge of the hyo-glossus divides into long flat branches, which are distributed to the lingualis, genio-hyo-glossus, hyo-glossus, and stylo-glossus.

Collateral Branches of the Lingual, are only two, viz., the descendens noni, and thyro-hyoid.

Descendens Noni, arises from the lingual as it hooks round the occipital artery, and lies on the external and anterior part of the sheath of the carotid above, but as it descends, passes to its internal side,

ultimately uniting with the communicans noni, to form the omo-hyoid plexus, for the supply of the sterno-hyoid, sterno-thyroid, and omo-hyoid; the descendens noni, however, may occasionally be found in the sheath, or even behind it.

Thyro-hyoid Branch, given off as the trunk of the lingual is passing above the os hyoides, runs downwards and forwards, over the lingual artery to the thyro-hyoid muscle, and on the hyo-glossus communicates with the gustatory, to form the hyo-glossal plexus. The lingual is essentially the motor nerve of the the tongue.

CERVICAL PLEXUS.

This plexus is formed by the anterior branches of the four first cervical nerves, which emerge from the foramina of conjugation, between the origins of the rectus capitis anticus major, which is in front of them, and those of the levator anguli scapulæ, which is behind them, the whole being overlapped by the sterno-mastoid. This plexus, when fully formed, occupies the posterior superior triangle of the neck, and requires a tedious and laborious dissection to expose it distinctly, owing to the manner in which it is invested by the dense areolar tissue of this region, the difficulty being still further increased by the numerous lymphatic glands which are imbedded in it. We will now proceed to describe the mode of its formation, taking each nerve separately.

The First Nerve, remarkable for its small size, emerges from the spinal canal, beneath the vertebral artery, between the occipital bone and the posterior half-arch of the atlas, and behind its oblique process; it winds forwards to the anterior part of its transverse process, and then bending downwards, anastomoses with an ascending branch from the second.

Second Nerve, somewhat larger than the first, passes out between the atlas and axis, also behind the articular processes, runs forwards to the intertransverse space, and divides into two branches—an ascending, and a descending—the former to communicate with the first, and the latter with the third cervical nerve.

Third Nerve, double the size of the second, emerges between the axis and third cervical vertebra, and (like the second) divides into two branches, one of which ascends to anastomose with the second, and another descends to unite with the fourth. From this nerve are principally derived, as we shall presently observe, the several filaments for the supply of the integuments of the neck.

Fourth Nerve, nearly similar in size to the third; on reaching the intertransverse space, or rather a little external to it, it receives the connecting twig from the third, and likewise sends off a

small branch of communication to the fifth cervical. The formation of the plexus, however, does not consist of a single communication between the several nerves that compose it; but the filaments which anastomose with each other around the transverse processes of the corresponding vertebræ, may be either one, two, or three in number; they are always extremely minute, and of course difficult to be demonstrated. This plexus also communicates with the eighth and ninth nerves, as well as with the superior cervical ganglion of the sympathetic. The plexus, when formed, is situated, as we have already stated, in the posterior superior triangle of the neck, and is of an irregular triangular shape; and the distribution of its several branches will be more easily understood by dividing them into a superficial and a deep set, the manner in which we propose to consider them.

Superficial Branches.—These, as their name implies, are all cutaneous, and from their course and direction have been divided into ascending and descending; the former consisting of the occipitalis minor, auricularis magnus, and superficialis colli; and the latter, of the supra-clavicular and supra-acromial.

Occipitalis Minor, arises principally from the second nerve, and arches upwards, parallel and close to the posterior edge of the sterno-mastoid, resting at first upon the splenius, then on the occipito-frontalis, and covered by the skin and fascia; it gives off branches backwards, to anastomose with the great occipital; and a few filaments forwards, to unite with the posterior auricular; both sets freely supplying the integuments, but giving no twigs to any of the muscles.

Auricularis Magnus, springs from the loop of connexion between the second and third cervical, passes at first backwards, till it reaches the posterior edge of the sterno-mastoid, around which it winds, and then turns forwards to rest on its outer surface, on which it ascends parallel but posterior to the external jugular vein, lying between the layers of the superficial fascia, and presenting a flattened appearance. Having arrived at the lower edge of the parotid, and thrown off several fine filaments to that gland, some of which can be traced to the skin of the face, it divides into two principal branches—a superficial, and a deep; the former, ascends through the notch between the lobule and tragus, and breaks up into numerous filaments for the supply of the skin of the inner part of the concha; while the latter, piercing a small portion of the parotid gland, and communicating with the portio dura, emerges on the mastoid process, beneath the retrahens aurem, and is distributed to the integument of the corresponding surface of the concha, having previously given off a small twig to the occipitalis minor. It, however, supplies no muscle.

SUPERFICIALIS COLLI, arises in common with the preceding, and like it, passes at first backwards, and then winds forwards around the posterior edge of the sterno-mastoid, which, as well the external jugular vein beneath which it runs, it crosses at a right angle: piercing now the cervical fascia, and then the platysma, it divides into two branches—a superior, and an inferior: the latter, dipping at first downwards, and then, arching upwards, divides into a number of fine filaments, which are distributed to the skin, as high as the os hyoides; while the former, taking an upward direction, and dividing in the same manner, supplies the integuments of the suprahyoid region, and anastomoses with twigs of the portio dura. We may here observe, that the two branches just described may arise distinctly from the plexus, and run an independent course; we have likewise seen an instance in which the superior was extremely large, and where it united directly with the cervical division of the facial, which was remarkable for its small size, both distributing filaments from the common trunk thus formed.

SUPRA-ACROMIAL and SUPRA-CLAVICULAR BRANCHES, arise from a loop between the third and fourth nerves, and proceed downwards, over the posterior inferior triangle of the neck, imbedded in the superficial fascia, some passing outwards, over the external extremity of the clavicle, where they are distributed to the skin over the anterior aspect of the deltoid (*acromial*), and others winding forwards and inwards, over the centre of that bone (*supra-clavicular*), to supply the integuments over the greater pectoral, a few of them extending inwards as far as the sternum.

DEEP BRANCHES, are divided into communicating and muscular: the former, consisting of only one, the *communicans noni;* and the latter, of numerous branches, distributed to the muscles in the vicinity.

COMMUNICANS NONI.—A small twig, sometimes double, arises from the loop of the second and third, and, passing downwards and inwards, over the internal jugular vein, unites on that vessel, and under the tendon of the omo-hyoid, with the descendens noni of the hypo-glossal, to form the omo-hyoidean plexus. This plexus is flattened and triangular in shape, and from it proceed numerous filaments for the supply of the omo-hyoid, sterno-thyroid, and sterno-hyoid, some of which proceed upwards in their several structures, as far as the os-hyoides, while others can be traced downwards nearly as far as their origins; its branches are likewise remarkable for the manner in which they are distributed, as they supply the deep and not the superficial surface of these muscles.

Muscular Branches, consist of those to the anterior recti, levator anguli scapulæ, trapezius, and rhomboidei, which need no special

description; but the *phrenic*, destined for one of the most important muscles engaged in the function of respiration, will require its course and distribution to be examined with greater accuracy.

The PHRENIC NERVE, properly speaking, takes its direct origin from the fourth cervical nerve, but it also receives a large reinforcing branch from the third, and occasionally another from the fifth, the latter uniting with it almost immediately after it is formed; but when this union does not take place, it will be found that the twig to the subclavius from the brachial plexus is always extremely large, and that it throws off to the phrenic an anastomotic branch, which passes downwards and inwards, to join it at a very acute angle, between the subclavian vein and cartilage of the first rib, and in front of the internal mammary artery. The RIGHT PHRENIC, thus formed, descends at first on the posterior edge of the scalenus anticus, but immediately above the superior aperture of the thorax it passes to its anterior border, being closely bound to the muscle by the deep cervical fascia; it here presents a decidedly flattened appearance, and is crossed at a right angle by the transversalis colli and humeri arteries, while the cervicalis ascendens runs upwards, parallel but internal to it; it next passes between the thyroid axis, which is internal to it, and the edge of the scalenus, which is external to it, crosses the subclavian artery at the junction of its first and second stages, but beneath the subclavian vein, and enters the cavity of the thorax, lying at first to the outer side of the internal mammary artery, then anterior to it, and ultimately internal to it; at this point the internal mammary throws off the comes nervi phrenici, which accompanies it in the rest of its course; reaching now the pericardium, to which it is bound down by the pleura, it runs downwards in front of the root of the lung, along the side of the pericardium, till it arrives at the upper surface of the diaphragm, where its peculiar mode of distribution to that muscle will be presently described.

The relative anatomy of the LEFT PHRENIC, while in the neck is similar to that of the right; on entering the thorax, it lies at first external to the pneumogastric nerve, but as it passes over the transverse portion of the arch of the aorta, and beneath the left vena innominata, it crosses that nerve and becomes internal to it. In the remainder of its course it has relations similar to those of the right; it is, however, of greater length, as the diaphragm does not ascend as high on this side as it does on the other; and its direction is also more oblique, from the inclination of the apex of the heart towards the left side. On reaching the diaphragm, the nerves from the opposite sides anastomose, by transverse filaments behind the cava, and then, dividing into numerous branches, supply both sur-

faces of the muscle, some ramifying between it and the pleura, and others perforating its structure, to supply its abdominal aspect, while several extend out as far as its costal attachments; twigs are likewise sent down to supply the crura, but it is doubtful whether any filaments are given to the solar plexus, and the same remark may be applied to the anterior pulmonary plexus.

The posterior branches of this plexus, will be described with those of the brachial.

BRACHIAL PLEXUS.

Exposed by removing the superficial structures from the lower and posterior part of the neck, and by separating the sterno-mastoid and the anterior scalenus from their attachments to the clavicle and rib, and throwing them upwards and forwards; it is to be presumed that the axilla has been already laid open, and properly cleared of its glands and loose areolar tissue, so that by now dividing the clavicle at the junction of its middle with its external third, and by removing the portion of bone between this point and the acromion process, the entire plexus will be exposed, as far down as its ultimate division into its branches for the supply of the arm, forearm, and hand.

The Brachial Plexus is formed by the anterior branches of the four last cervical nerves and that of the first dorsal; they all increase very slightly in size as they descend, with the exception of the first dorsal. As they emerge from between the anterior and middle scaleni, they present the following arrangement in the formation of the plexus :—The fifth and sixth nerves run downwards and outwards, at first separately, but gradually converging, at length unite, at the outer edge of the anterior scalenus, into a single cord. The seventh likewise escapes between the same muscles, and passes with less obliquity outwards, nearly as far as the clavicle; while the eighth cervical runs outwards as far as the edge of the scalenus, and there unites with the first dorsal, which sweeps upwards and outwards in front of the neck of the first rib, and behind the superior intercostal artery, to join with it. The primary or formative nerves are now reduced to three, and at the posterior edge of the anterior scalenus, the following additional interchange between their fibres takes place: —The compound trunk of the fifth and sixth divides into two, and sends up one branch to the cervical plexus, which afterwards becomes the reinforcing twig of the phrenic, and another downwards to the seventh, which also bifurcates into ascending and descending branches for the compound trunks above and below. The trunk of the eighth and first dorsal likewise anastomose with the nerve above it, and the brachial plexus formed in this manner

lies partly in the posterior inferior, and partly in the posterior superior triangle of the neck, on a plane superior and external to the subclavian artery, bound down and isolated by a process of the deep cervical fascia, which is prolonged on it from the margin of the anterior scalenus. From this point it continues its course downwards, passes under the clavicle and subclavius muscle, resting upon the first rib and first indigitation of the serratus magnus, crosses the axilla behind, and external to the artery, and ultimately terminates on the tendon of the subscapular, where it finally divides into its branches of supply for the upper extremity. The figure of the plexus, taken as a whole, resembles an hour-glass, being expanded at its extremities, and contracted in its middle, and its branches may be classified into those given off above the clavicle, or supra-clavicular, and those given off below it, or infra-clavicular.

Supraclavicular consist of muscular branches to the subclavius, scaleni, levator anguli scapulæ, rhomboids, supra and infraspinatus, teres major, and minor, latissimus dorsi, subscapular, greater and lesser pectoral, and serratus magnus; those to the three last being more commonly known as the anterior, middle, and posterior thoracic.

Branch to the Subclavius, arises from the plexus a little above the clavicle, and soon divides into two branches, one for the muscle, and the other to pass down in front of the subclavian vein, to communicate with the phrenic nerve; but the last, is not always present.

Branches to the Scaleni, are short twigs, given off as the nerves emerge from between them.

Branch to the Levator Anguli Scapulæ.—Always very large; arises from the upper part of the plexus, and is supplied to the under surface of the muscle.

Branches to the Rhomboidei, may spring either from the lower part of the cervical, or upper part of the brachial plexus; they present nothing remarkable in their distribution.

Suprascapular, or Branch to the Capsular Muscles, is always a large nerve, arising from the upper and back part of the plexus, as high in fact as the fifth and sixth; it passes downwards and outwards, superior and posterior to the posterior belly of the omohyoid, reaches the superior costa of the scapula; runs through the notch, beneath the transverse ligament which separates it from the artery of the same name, enters the supraspinous fossa, and divides into two branches, one of which is distributed to the supraspinous muscle, while the other glides beneath the acromion process, under the spino-glenoid ligament, to supply the infraspinous, and teres minor.

Branch to the Subscapular, is a short, thick nerve, arising immediately above the clavicle; it runs downwards and outwards, and buries itself in the upper border of the subscapsularis muscle.

Anterior Thoracic, or Branch to the Great Pectoral, comes off from the plexus as it lies beneath the clavicle; it then passes downwards beneath that bone, and, emerging between the subclavius muscle and subclavian vein, divides into two branches—a communicating, and a muscular; the former, anastomosing between the axillary vessels with the middle thoracic, so as to form a nervous loop around the artery; while the latter, perforating the costo-coracoclavicular ligament, divides into numerous filaments, that bury themselves in the great pectoral muscle, which they supply as far as its origins.

Middle Thoracic, or Branch to the Lesser Pectoral, smaller than the last, but arising from the same part of the plexus, passes downwards behind the axillary artery, and between it and the vein forms a loop with the anterior thoracic; from this loop two sets of branches are given off, some of which are distributed to the lesser pectoral, and others to the greater.

Posterior Thoracic, Long Respiratory Nerve of Bell, or Branch to the Serratus Magnus, larger than either of the two preceding, arises from the back part of the plexus, from the fifth and sixth nerves; it passes almost vertically downwards, resting on the posterior scalenus, and covered by the plexus emerges from beneath the clavicle, and lies on the inner wall of the axilla, between the serratus magnus, and subscapularis; it is distributed to the serratus magnus, a large branch perforating and supplying its upper part, whilst fine and long filaments can be traced downwards, to its lowest indigitations, in which they are ultimately lost.

Infraclavicular Division.—Before proceeding to the description of the terminal branches of the plexus, it will be necessary to advert to a nerve which arises immediately below the clavicle, and must be designated as the *inferior subscapular*, to distinguish it from that branch to this muscle, which has been already described. This nerve, remarkable for its size as it springs from the lower and outer part of the plexus, descends through the loose areolar tissue of the axilla, and divides into three branches—one for the inner surface of the subscapularis, a second for the teres major, and a third for the latissimus dorsi; it can be traced along the anterior margin of that muscle, as far nearly as its origin.

The ultimate division of the plexus, takes place as it lies on the tendon of the subscapularis, and the nerves springing from it have generally been classed into those that are external, internal, and posterior to the axillary artery; the first consisting of the external cuta-

neous, and outer head of the median; the second, of the internal cutaneous, inner head of the median, ulno-cutaneous, and ulnar; and the third, of the circumflex and musculo-spiral. We will now proceed to examine them individually.

External Cutaneous, likewise known as the *musculo-cutaneous* or *perforans Casserii*, being, after the internal, the smallest branch of the plexus, arises in common with the outer head of the median, descends obliquely downwards and outwards, over the neck of the humerus, and anterior circumflex artery; perforates, or sometimes passes under, the coraco-brachialis; then lies between the biceps in front, and the brachialis anticus behind, where it occasionally communicates by a delicate filament with the median; about two inches above the elbow-joint, it escapes from beneath the outer edge of the biceps humeri, and becoming subcutaneous, divides into two branches, an anterior, and posterior; the former, running downwards along the front and radial side of the fore-arm, beneath the median cephalic vein, and in the layers of the superficial fascia, can be traced as low down as the thenar eminence; in its course along the fore-arm it throws off numerous filaments to the integuments, and at the carpus, communicates with the radial, afterwards distributing slender branches to the skin of the thumb, with others which accompany the radial artery, and are lost on the synovial membrane of the radio-carpal articulation; the latter, or posterior division, winds to the back part of the fore-arm, descends nearly vertically, likewise invested in the superficial fascia, supplying the integuments in its course, and can be traced only as far as the back part of the carpus. The humeral distribution of the external cutaneous nerve is muscular, which seems to prove that it should be considered merely as an offset of the median; it supplies very freely the coraco-brachialis, biceps, and brachialis anticus.

Internal Cutaneous, smaller than the preceding, arises in common with the inner head of the median; descends almost vertically, and at variable distances below the axilla, perforates the fascia, and becomes subcutaneous; here it throws off a small twig for the supply of the integuments of the inner side of the arm; continuing its course now downwards, anterior and internal to the basilic vein, about four inches above the internal condyle, it divides into an anterior, and posterior branch; the former, then subdivides into two, both occasionally, and sometimes only one, passing in front of the median basilic vein, the most external crossing to the middle of the fore-arm, the internal to its inner side, both supplying the integuments with numerous filaments, which can be traced down as far as the carpus. The posterior division descends obliquely downwards and inwards, and on reaching the dorsal aspect of the fore-arm, throws off a recurrent branch to

anastomose with the nerve of Wrisberg, above the olecranon process; it then proceeds downwards, as far as the posterior annular ligament, freely supplying in its descent the skin of the back and inner part of the fore-arm.

Nerve of Wrisberg, or Lesser Cutaneous, is a very small twig, which springs from the plexus rather high up; it passes downwards and outwards, and anastomoses with the intercosto-humeral from the second dorsal, with which is distributed to the integument of the posterior and inner part of the arm, as far down as the elbow-joint.

Median Nerve, is a very large trunk, which arises by two heads, that embrace the axillary artery; the external long, and intimately connected with the external cutaneous; the internal shorter and thicker, continuous with the internal cutaneous and ulnar; the union of these two heads, takes place in front and a little external to the vessel, but as it descends it crosses the artery generally in front, but sometimes behind, to reach its inner side; at the bend of the elbow, it is covered by the semilunar fascia of the biceps, and then disappears between the two heads of the pronator radii teres, the external or coronoid attachment of the muscle separating it from the ulnar artery, which it crosses; it now descends, between the superficial and deep flexors of the fingers, passes beneath the annular ligament, between the flexor communis and flexor pollicis, and reaches the palm of the hand, where it is flattened and expanded lying beneath the palmar fascia, and the superficial arch of arteries; here it divides into six terminal branches, the most external of which supplies the muscles of the ball of the thumb, while the remaining five are distributed in the following manner:—One runs to the outer side of the thumb; a second to its inner side; a third to the outer side of the index finger; a fourth to the cleft between the index and middle, and there subdividing supplies their opposed surfaces; and a fifth to the cleft between the middle and ring fingers, which likewise subdivides for their opposed surfaces. Those digital nerves are at first beneath the arterial arch, but on arriving at the base of the first phalanges, the digital arteries split and pass behind them, so that the nerves become the most superficial, but opposite the middle of the second phalanx they again re-perforate, and resume their primary position with respect to each other, which they maintain to their termination; besides the continued trunk which is destined for the anterior aspect of the fingers, each throws off a dorsal lateral branch, which supplies the root of the nail. The termination of the anterior filaments is in a series of loops, which are distributed to the tactile papillæ of the extremities of the fingers.

In connexion with this nerve, we must here mention certain remarkable structures which are found principally in the extremities,

but not solely confined to them, called, after the name of their discoverer, *Paccinian corpuscles.* They are situated in the areolar tissue, on the extremities of the small offsets thrown off from the trunk of the nerve, and connected to it by the neurilemma which is prolonged over them. In figure they are generally oval, averaging in the human subject a line in length, or perhaps a little more, and consist of a series of laminæ from thirty to sixty in number, overlapping each other like the tunics of a bulb, but with this difference, that all the laminæ, with the exception of the ten or twelve most internal, are separated from each other by a thin fluid, all however, being connected by fine processes passing between the fibrous laminæ, which closely unite them with each other. The fluid which fills the several intercapsular spaces does not communicate, and it may be discharged by puncture from one while the remainder still continue in a state of tension ; but if once completely emptied and allowed to dry, they will not again become distended if immersed. The wall of each capsule consists of two layers, the most internal of which contains minute oval nuclei, while the external is apparently fibrous. In the middle of the corpuscle is a hollow stalk, stretching through its long axis, and into this the nerve enters, having previously lost the white substance of Schwann, which it had retained up to its perforation of the last capsule, and then running to the distal extremity of the cavity, the stalk-like process suddenly expands into a small knob, which affixes itself to the inner side of the capsule. It was once supposed, that the Paccinian corpuscles were in some way connected with the sense of touch, but their existence in several situations where this function could not possibly be exercised, must completely negative that idea.

The Median Nerve, gives off no branches in the arm, except occasionally a small anastomotic twig to the external cutaneous; but in the fore-arm, its filaments of supply are very numerous. In addition to several which perforate the elbow-joint, it distributes branches to all the muscles on the front of the fore-arm, with the exception of the flexor carpi ulnaris, and half of the flexor profundus, which are supplied by the ulnar. It also throws off two, which have received distinct names, having been called the anterior interosseous and palmar cutaneous.

Anterior Interosseous, a long slender branch, arising from the median, at the bend of the elbow, passes downwards, on the interosseous ligament, between the flexor pollicis on the outside, and the flexor profundus on the inside, giving numerous filaments to each, as it descends; and in front, and external to the artery of the same name ; it then runs beneath the pronator quadratus, and divides into two branches, one of which is distributed to the deep surface of that

muscle, while the other passes through the interosseous space, to communicate with the posterior interosseous, from the musculo-spiral.

Palmar Cutaneous is given off a little above the annular ligament, over which it passes, and separating into two branches, the external winds outwards to the ball of the thumb, the integument of which it supplies; while the internal, passes downwards to the palm of the hand, and is distributed to the skin of that region, sending also a twig to the palmaris brevis.

Ulnar Nerve.—Is rather smaller than the last described, with the inner head of which it arises in common, and passes obliquely downwards and inwards, at first to the ulnar side of the brachial artery, but soon gradually diverges from it, and ultimately joins the inferior profunda, to which it lies internal; both now perforate the internal intermuscular septum, then the sheath of the triceps, and passing into the groove between the internal condyle and olecranon process, between the two origins of the flexor carpi ulnaris, the nerve alone then arches forwards to the front of the fore-arm, where in its upper third it lies internal, but at some distance from the ulnar artery; but as it, however, descends, it gradually approaches that vessel, so that in its middle third it is quite close to it, and in its inferior, while still internal, it is on a plane slightly posterior to it; crossing now the anterior annular ligament, to which it is bound down by an expansion from the ulnar flexor, it reaches the palm of the hand, and divides into two branches—a superficial, and deep; the former, again subdividing into two, the internal of which is distributed to the inner aspect of the little finger, while the external, having thrown off a twig of communication to the median, continues its course to the fourth intercarpal space, where bifurcating, each is distributed to the opposed surfaces of the fourth and fifth fingers; their terminal extremities are marked with the same Paccinian corpuscles as are found on the median, and dorsal lateral filaments are also given off for the supply of the root of the nail. The posterior, or deep branch, sinks between the origins of the abductor, and flexor minimi digiti, in company with the deep division of the artery, supplying in its course the muscles of the little finger, when it winds outwards beneath the tendons of the deep flexor, throwing off branches to the lumbricales and interossei, and ultimately terminates in supplying the adductor, and deep head of the flexor pollicis brevis.

The humeral division of this nerve gives off no branches whatever, but in the fore-arm, after sending a few filaments to the elbow-joint, it supplies freely the flexor carpi ulnaris, and flexor profundus; about the middle of the fore-arm, a twig is likewise thrown off which perforates the fascia, to anastomose with the internal cutaneous: and another (dorsalis carpi ulnaris), very large at the upper part of its

inferior third, which winds backwards around the ulna, beneath the tendon of the flexor ulnaris, and becoming cutaneous a little above the posterior annular ligament, where it communicates with the dorsalis manûs of the radial, divides on the back of the hand into two branches—an internal, which is distributed to the integument of the inner side of the little finger; and an external, which, divides into two, one of which proceeds to the cleft between the little and ring fingers, and subdividing, supplies the skin of their opposed surfaces; while the other, on reaching the cleft between the ring and middle, likewise bifurcates to supply their adjacent aspects.

MUSCULO-SPIRAL.—The largest branch of the entire plexus, and as such appears to receive twigs from the whole of its formative nerves, passes at first vertically downwards, behind the ulnar; then winds backwards and outwards, at first behind the axillary artery, and then in company with the superior profunda, between the internal and long head of the triceps; it then passes between that muscle and the bone, the latter of which it grooves in a spiral manner, and emerging at length on the front and outer part of the arm, about three inches above the external condyle, it lies at first between the brachialis anticus and the supinator longus, and then between the latter muscle and the extensor carpi radialis longior, where it divides into two branches—an anterior or radial, and a posterior or interosseous.

Anterior, or *Radial*, descends in company with the radial artery, being in the upper third of the fore-arm at a slight distance from, and external to it; in the middle third quite close to it, but still to its outer side; while in its inferior it leaves it altogether, winding backwards around the radius, and under the tendon of the supinator longus; on reaching the back of the forearm, it becomes subcutaneous a little above the annular ligament, and receives the name of dorsalis manus; here it divides into two branches—an external and internal; the former, which is very small, runs downwards and outwards along the external side of the thumb, to supply the integuments of that part; while the latter, subdivides into two—of which one proceeds to the cleft between the thumb and index finger, and the other to that between the index and middle—where each again divides into two, for the supply of the opposed sides of the digits of those spaces, the most internal generally communicating with the dorsal of the ulnar.

Posterior, or *Interosseous*, the other terminal branch of the musculo-spiral, is larger than that already described. It passes backwards and outwards, perforating the supinator brevis, and lying close to the neck of the radius, but to its outer side; and on reaching the back of the fore-arm, divides into two sets of branches—

a superficial, and deep: the former, by numerous filaments supplying the superficial muscles in this region, while the latter, having distributed its twigs to the deeper set, continues its course downwards, but now very much reduced in size, passes through the fourth groove of the radius, and under the tendon of the extensor communis, and is distributed by gangliform filaments to the structures composing the carpus. The collateral branches of the musculo-spiral are, the internal cutaneous, muscular, and spiral cutaneous.

Internal Cutaneous.—Usually double, arises very high up, and after proceeding vertically downwards, for a short distance, perforates the fascia, and becoming subcutaneous, continues its course, supplying the integuments of the inner and back part of the arm as far as the olecranon process.

Muscular Branches.—Several to the deep surface of the triceps, and one extremely long to the anconæus.

Spiral Cutaneous.—Rather a large branch, which comes off from the nerve as it lies to the outside of the humerus; it perforates the external head of the triceps, then the fascia, and continuing its course downwards and backwards, is distributed to the integument of the outer and posterior part of the fore-arm, as low down as the carpus.

Circumflex Nerve.—Very large, arising from the plexus by a common trunk with the last described; it passes immediately backwards, in company with the posterior circumflex artery, through a quadrilateral space, bounded externally, by the neck of the humerus: internally, by the long head of the triceps; above, by the capsule of the joint; and below, by the conjoined tendons of the latissimus dorsi and teres major; here it occasionally throws off twigs to the teres minor, and subscapularis. Arriving now, at the posterior part of the shoulder, it divides into two sets of branches—cutaneous, and muscular—the former pierce the fascia, and ramify in all directions through the integument covering the deltoid, while the latter are distributed to the deep surface of that muscle, and can be traced as far as its insertion.

DORSAL, OR INTERCOSTAL NERVES.

The dorsal nerves are twelve in number, and are found to decrease gradually in size from the first to the tenth, where a slight increase is visible in the two last. In the description of their origin from the spinal marrow we have already alluded to their double roots, the ganglion formed on their posterior, their subsequent union and division into proper anterior and posterior, with the first of which we have only now to deal, proposing to examine them in succession from above downwards.

First Dorsal, or Cervico-brachial, is a large nerve which emerges from the foramen of conjugation, between the first and second dorsal vertebræ ; we have already explained, how it crosses upwards and outwards, in front of the neck of the first rib, and behind the superior intercostal artery, to join the last cervical, for the formation of the brachial plexus ; but just as it escapes from the intervertebral foramen, it always throws off a small branch, a representative of the first intercostal, which however, does not truly enter the space between the two layers of muscles, till it reaches the anterior extremity of the rib; it then passes between them, and supplies them, and is ultimately distributed to the integuments of the sternum.

Second Intercostal.—Much smaller than the last, takes a very peculiar course, first passing obliquely upwards over the neck of the second rib to reach the first intercostal space, through which it runs until it reaches its middle, when it again re-crosses the second rib to reach the second intercostal region, where it divides into two branches —a proper intercostal, and perforating : the former, continues its course like the others, supplying the muscles, and ultimately ramifying in the integuments over the sternum ; while the latter, after perforating the external layer of intercostal muscles, passes downwards and outwards, and, after anastomosing with the ulno-cutaneous, divides into two branches, which are distributed to the inner and back part of the arm, as far down as the olecranon process.

Third Dorsal.—Smaller than the preceding, having passed into its corresponding intercostal space, and proceeded a little beyond its middle, divides also into a proper intercostal, and a perforating ; the former, pursuing a similar course to the last described, to be lost on the skin of the sternum ; while the latter, perforating the external intercostals between the origins of the serratus magnus, first supplies the mammary gland, and then crosses the floor of the axilla, to be distributed to the back part of the arm.

Fourth, Fifth, Sixth, and Seventh Dorsal, are, generally speaking, similar in their characters, running outwards and forwards over the anterior costo-transverse ligament, to enter the intercostal spaces. A little beyond the angle of the rib, each throws off a small branch, which winds forwards, on the upper margin of the rib below, but this is not always constant. Dividing now into two branches, the smaller or proper intercostal, continues its course to the sternum, to be distributed to the integuments over it, supplying as it proceeds numerous looped filaments to the adjacent muscles, whilst the larger or external, perforates the outer layer of intercostals, beneath the serratus magnus, which it also pierces, supplying it as well as the recti, triangularis sterni, and external oblique, with

the integuments of the thorax and mammary gland, to which it distributes several cutaneous twigs.

Eighth, Ninth, Tenth, and Eleventh Dorsal, belong to the intercostal spaces of the false ribs, which likewise, after proceeding for some distance, divide into a continuous trunk, and a perforating branch; the first, pursuing its course as far as the curved cartilages of those ribs, when they perforate the indigitations of the diaphragm, and pass between the internal oblique muscles and the transversalis, as far as the outer edge of the rectus, where they throw off cutaneous branches, for the supply of the anterior part of the abdominal wall; the nerve, now greatly diminished in size, pierces the sheath of the rectus, and reaching its posterior surface, freely supplies it, some of its filaments also passing through it, to ramify in the integuments over the linea alba. Their perforating branches, like the others, pierce the external layer of intercostals, on the same line as those already described, and then, escaping through the external oblique, are distributed to the integuments on the lateral parts of the abdomen.

Twelfth, or, Last Dorsal.—This, as contrasted with those already described, is a large branch which emerges between the last rib and the first lumbar vertebra, and runs obliquely downwards along the inferior margin of the former, and then piercing the transversalis aponeurosis, divides into two branches; one internal, which can be traced between the internal oblique and transversalis, as far as the sheath of the rectus, where it throws off a few cutaneous filsments, and then perforates it, to supply the inclosed muscle; the other, external and much larger, which descends obliquely outwards and downwards, enveloped in a process of the transversalis aponeurosis, beneath the ligamentum arcuatum falsum, and on the quadratus lumborum, and reaching the crest of the ilium a little anterior to its centre, pierces the internal and external oblique, to divide into a number of cutaneous twigs, which ramify in the integuments and fat of the glutæal region. The last intercostal, always gives off a small branch of communication to the lumbar plexus; but the situation in which it may be found is exceedingly variable, as we have seen it thrown off immediately after the emergence of the nerve between the rib and the first lumbar vertebra, or about the middle of the former, or towards its outer extremity, but it is always easily recognised, by its peculiar wavy course and flattened appearance. It joins directly with the first lumbar, and hence its name dorso-lumbar.

Before concluding our account of these nerves, it may be necessary to state, that each receives a communicating filament from the corresponding dorsal ganglion of the sympathetic; that each passes in

front of its corresponding anterior costo-transverse ligament, and under the pleura to reach the proper intercostal space, where they lie below the artery and vein, the latter vessel, and not the former, occupying the groove in the rib above.

LUMBAR PLEXUS.

This important plexus can only be examined after the abdomen has been laid open and its contents removed; then, by raising cautiously the anterior three-fourth of the psoas, or that portion which is attached to the sides of the bodies of the lumbar vertebræ, it will be observed lying on the deeper origins of that muscle, where it springs from the transverse processes; its branches must then be each cautiously followed to its destination. The plexus is formed by the anterior branches of the first, second, third, and fourth lumbar nerves, which communicate with each other by filaments that are nearly vertical; it also receives the last dorsal, and twigs from the lumbar ganglions of the sympathetic, which descend between the vertebral origins of the psoas, to unite with it. These nerves will be observed to increase rapidly in size from the first to the last, which is extremely large and flattened, while the plexus formed by their junction is of a triangular shape, with the base corresponding to the side of the vertebral column, and with the apex externally and inferiorly constituted by the anterior crural nerve. It consists primarily of four great divisions, viz., inguino-cutaneous, anterior crural, obturator, and lumbo-sacral.

Inguino-cutaneous is again subdivided into four branches which are known by the following names:—Superior or ilio-scrotal, middle or small musculo-cutaneous, inferior or external musculo-cutaneous, and internal or genito-crural.

Superior, or *Ilio-scrotal*, large as contrasted with the others; arises from the first lumbar, and having perforated the psoas muscle, passes downwards and outwards, between the layers of the transversalis aponeurosis, beneath the kidney, and over the quadratus lumborum muscle; it now reaches the posterior part of the crest of the ilium, and here piercing the transversalis muscle, divides between it and the internal oblique, into two branches, an external, or glutæo-cutaneous, which perforates the last-named muscle, and then escapes between the margins of the external oblique and the latissimus dorsi to divide into filaments, which ramify in the integuments over the glutæal region; and an internal or continued trunk, which pursues its course between the transversalis and internal oblique, close to the crest of the ilium, and beneath the internal circumflex ilii artery, till it arrives at the anterior superior spinous process of the ilium, where

it divides into two branches, an abdominal, and scrotal; the former, after communicating with the small musculo-cutaneous, runs inwards, still between the same muscles, till it reaches the rectus, where some of its filaments are distributed to that muscle, and others to the skin over it, while the latter or scrotal, winds downwards till it reaches the cord, in company with which it leaves the external abdominal ring, and divides into two branches, one of which is lost in the upper and back part of the scrotum, while the other supplies the integuments of the groin.

Small, or *Middle Musculo-cutaneous*, arises in common with the last, from the first lumbar, and having pierced the psoas muscle, passes downwards and outwards, towards the anterior superior spinous process of the ilium, running parallel, but inferior to the ilio-scrotal, and occasionally terminating by anastomosing with it at this point; or, it may continue its course, between the internal oblique and transversalis, nearly as far as the outer edge of the rectus, when it becomes cutaneous by perforating the internal and external oblique, and is distributed to the integuments of the lower part of the abdomen; while between the muscles, it always anastomoses with the ilio-scrotal.

External, or *Inferior Musculo-cutaneous*, arises from the second lumbar nerve, sometimes receiving a branch from the third; it perforates the psoas, and runs downwards and outwards, over the iliacus internus, invested in a tubule of the fascia iliaca; it now crosses under Poupart's ligament, below the anterior superior spine of the ilium, and beneath the fascia lata of the thigh, and between the sartorius, and tensor vaginæ femoris, divides into two branches—a posterior or glutæal, and an anterior or femoral. The glutæal, winds downwards and backwards, passing in its course either over, or through, or under the tensor vaginæ femoris, when it separates into filaments for the supply of the integuments over the glutæal region; while the lateral or femoral branch, after passing downwards for a short distance, divides into two—an external, running downwards and backwards, to be distributed to the skin of this part as far down as the lower third of the thigh, in inverted loops; and an internal, which can be traced downwards, nearly as low as the patella, where, bending backwards, it becomes arched and flattened, and supplies the integuments on the outer side of the thigh, a little above the knee.

Genito-crural.—Very thin and slender; arises from the second lumbar nerve, and passing obliquely downwards and forwards, it pierces the psoas muscle, then rests on its anterior and inner part, enveloped in a thin tubule of fascia, and covered by the ureter and spermatic vessels. About two inches above Poupart's ligament, it is

generally found lying on the outer side of the external iliac artery, and here divides into two branches, a genital, and crural; the former passes upwards and outwards, to reach the internal abdominal ring, through which it emerges, and as it traverses the oblique inguinal canal behind the cord, it distributes several twigs to the transversalis and internal oblique; escaping now through the external ring, it continues its course downwards and inwards, to supply the integuments of the scrotum in the male, and the labia majora in the female. The crural, or femoral branch, passes downwards, on the femoral artery in its sheath, and close to the outer margin of the crural ring, and having descended about half-an-inch, it pierces the sheath, then the fascia of the thigh, and supplies the integuments on its anterior part as far down as its middle third.

Anterior Crural Nerve.—Springs principally from the third and fourth, receiving also a branch from the second; its formation takes place within the psoas, and on emerging from that muscle, it lies buried between it and the iliacus, and covered by the fascia iliaca, being at this point fully an inch from the external iliac artery, yet separated from it by the psoas and fascia, but as it passes under Poupart's ligament it is quite close to that vessel. While within the pelvis, it throws off several slender branches to the iliacus, but generally only one, or sometimes two, to the psoas. On reaching the upper part of the thigh, the nerve becomes flattened and expanded, and after running about two inches below Poupart's ligament, it is pierced by the external circumflex of the profunda, which divides it into two sets of branches; muscular, and musculo-cutaneous.

Muscular, large and distinct branches, which supply the rectus, vastus externus and internus, cruræus, and subcruræus, and to these may be added the adductor longus, brevis, and pectinæus, which likewise receive a few filaments from the twig destined for the supply of the femoral vessels.

Musculo-cutaneous, is likewise divided into two sets of branches—muscular, that run along the deep surface of the sartorius, which they ultimately enter and supply; and cutaneous, three in number, a superior, middle, and inferior. Of these, the first or superior passes downwards beneath the sartorius, and then, perforating its upper third and the fascia, divides about the middle of the thigh into two branches which can be traced down on its front and inner part, as far as the patella, where they terminate in flattened anastomotic arches. This nerve communicates, in its course downwards, with the crural division of the genito-crural. The second or middle, continues in the sheath of the sartorius, much lower down; but it ultimately pierces it a little below the middle of the thigh, and becomes cutaneous; on reaching the internal condyle, it is reflected outwards and slightly upwards, over

the patella, in the subcutaneous areolar tissue, in which it ramifies, and anastomoses with the patellar branch of the internal saphenous. The third or accessory cutaneous, passes downwards, along the inner side of the sartorius, and about its middle divides into two branches —a superficial, which, becoming cutaneous, and crossing to the inner side of the thigh, accompanies the internal saphenous vein as far as the internal condyle, where it joins the latter nerve; and a deep, which runs on the anterior surface of the femoral artery in the inferior fourth of its course, and terminates in forming a plexus around it, as it passes through the aperture in the adductor magnus, to reach the popliteal space, here freely anastomosing with the articular branch of the obturator.

Vaginal Branch, very variable in its mode of origin; it not only supplies the sheath of the femoral vessels, but also sends branches to the adductors, longus, brevis, and pectinæus.

Internal Saphenous.—This nerve, remarkable from its very long course, and from its distribution, must be also considered as cutaneous; it arises from the inner side of the anterior crural, and immediately after its origin, receives a twig of communication from the obturator, which runs between the femoral and profunda arteries in order to reach it; passing now downwards, it lies at first to the outside of the former vessel, but afterwards directly in front of it, and at the lower part of Hunter's canal, where the artery winds backwards and outwards to enter the popliteal space through the opening in the triceps, it crosses to its inner side, then leaves it altogether, and gets into company with the anastomotica magna; it now runs downwards along the tendon of the adductor magnus, then between the tendons of the gracilis and sartorius, and at the inner side of the knee becomes cutaneous, and joins the internal saphenous vein, lying at first anterior to it, then behind it, and then in front of it again; with it, it continues its course downwards, along the posterior and inner part of the leg, passes in front of the internal malleolus, and then winds forwards on the inner side of the foot, the integuments of which it supplies as far as the great toe. While in the thigh, the saphenous occasionally throws off a cutaneous branch, which descends at first between the sartorius and gracilis, and then perforating the fascia, becomes superficial, and is distributed to the skin on the inner and back part of the knee-joint; but this branch may be sometimes an offset from the obturator. Behind the internal condyle, a second branch is always given off which perforates the sartorius, and then, descending for a short distance, again winds upwards and outwards over the ligamentum patellæ, and is lost in fine cutaneous filaments in the skin on the inner side of the joint; while from the upper part or concavity of the arch thus formed, twigs are sent up, to supply the

integuments over the patella, while others pass off from its convexity to be distributed to the superficial structures on front of the upper third of the tibia. As the internal saphenous continues its course on the inner and back part of the leg, much diminished in size from having given off this patellar branch, it throws off several filaments both to its inner and back part, and also a branch about two inches above the ankle-joint, which passes downwards and backwards to supply the integuments on the internal malleolus and heel. On the inner side of the foot it sends filaments also to the several articulations, and others to anastomose with the musculo-cutaneous of the peroneal.

Obturator Nerve, much smaller than the anterior crural, arises from the third and fourth lumbar nerves, and crossing the ilio lumbar artery, which separates it from the lumbo-sacral nerve, passes outwards and forwards, first between the angle of bifurcation of the external and internal iliac arteries, and then along the wall of the true pelvis beneath the peritonæum, and buried in the subserous tissue, having below it its own artery, and above it the external iliac vein; arriving now at the anterior wall of the cavity, it escapes through the oblique groove in the upper part of the thyroid foramen, where it perforates in succession the following parts:—1. Vesical fascia; 2. A few fibres of the levator ani; 3. The obturator fascia; 4. Obturator internus; 5. The obturator membrane; and 6. The obturator externus, which it supplies as it passes through; but gives off no branch to any of the muscles within the pelvis. Emerging now in the femoral region beneath the pectinæus, it divides into two branches—an anterior, which descends between the adductor longus and brevis, and terminates in three branches, for the supply of both these muscles, as well as the gracilis; while a few twigs become cutaneous, and can be traced down to the integument on the back part of the leg, to which they are distributed; the posterior division, the larger of the two, lies at first between the adductor brevis and magnus, and here breaks up into a number of filaments for the supply of the latter muscle; while one, longer than the others, runs down between the adductor magnus and the linea aspera, and, perforating the attachment of this muscle in its lower third, enters the popliteal space, where it pierces the ligamentum posticum of Winslow, and is distributed to the knee-joint. Here it will be necessary to allude to a branch, not, however, invariably present, termed the *accessory obturator;* when it does exist, it usually arises from the obturator itself, immediately after its origin, or it may spring from the third or fourth lumbar nerves as a separate branch; it passes downwards and forwards, on the inner side of the psoas, and beneath the fascia, crosses over the horizontal ramus of the pubis, then dips beneath

the pectinæus, to the under surface of which it gives filaments, as well as to the femoral articulation, and ultimately terminates by uniting with the anterior division of the obturator itself. The communicating branch, between the great obturator and the internal saphenous, may be almost constantly found in the angle of bifurcation between the femoral and profunda arteries; but from its very small size, and the manner in which it is involved in the loose areolar tissue so abundant in this part, it frequently escapes observation.

Lumbo-sacral, the largest division of the entire plexus, arises from the fourth and fifth branches, sometimes receiving a twig from the third; it passes downwards into the pelvis, resting on the sacro-iliac synchondrosis, and covered by the internal iliac, glutæal, and ilio-lumbar arteries, with their corresponding veins, and a little above the upper margin of the great sciatic notch divides into two branches—a communicating, which passes downwards and outwards to unite with the first sacral nerve; and the superior glutæal, which, emerging from the upper and anterior part of the notch, above the pyriformis, passes forwards between the glutæus medius and minimus, and divides into two branches—a superior, which courses along the upper margin of the latter muscle, supplying both it and the medius; and an inferior, which, crossing it about its middle, gives filaments to both, and, emerging from between them, pierces the sheath of the tensor vaginæ femoris, in which muscle it is ultimately expended.

SACRAL PLEXUS.

The sacral nerves are six in number, and unlike the lumbar, decrease in size as they descend. The first and second, which are very large, pass obliquely downwards and outwards, and unite on the pyriformis; the third and fourth, which are only half as large as either of the two preceding, run more horizontally outwards, and join the compound trunk of the first and second; the fifth, on emerging from the sacral foramen, divides into two branches, one of which ascends to unite with the fourth, while the other descends to communicate with the sixth; this last nerve is so very small that its very existence has been sometimes denied; but it always may be found by cautious dissection, and, while still within its proper foramen, divides into its anterior and posterior branch, the latter of which will be hereafter alluded to, but the former, on reaching the front of the sacrum, again subdivides into two branches, one of which ascends to join the fifth, and the other descends to supply the integument about the coccyx, sending likewise a few filaments to the glutæus maximus.

The Sacral Plexus is, however, constituted by the four first nerves only, with the communicating branch of the lumbo-sacral and some twigs of the sympathetic. It is of a triangular shape, with the base at the sacrum, and the apex at the great sciatic notch, and it rests on the pyriformis, while it is covered by the bladder, rectum, vesiculæ seminales, and posterior layer of the pelvic fascia, which separates it from the descending branches of the internal iliac artery. While within the pelvis it gives off branches to the bladder and rectum, and to the uterus and vagina in the female—some directly to these organs, and others to join the hypogastric plexus; these being principally derived from the fourth and fifth nerves; it likewise supplies the following muscles:—Pyriformis, levator ani, and obturator internus; that for the pyriformis, arises generally from the third, and, dividing into two, sinks into its anterior surface; that for the levator ani, likewise consisting of two, but derived from the fourth, one of which is distributed to the middle, and the other to the anterior part of the muscle; and that for the obturator internus, which usually springs from the first, passes out through the great sciatic notch, then crosses the spine of the ischium, enters by the lesser sciatic notch, and, dividing into three or four filaments, is distributed to the pelvic surface of the obturator internus; in addition to these, it likewise supplies special branches to the superior gemellus, and quadratus femoris. The external branches of the plexus are the pudic, inferior glutæal, posterior cutaneous, and lesser and greater sciatic.

Pudic Nerve.—Rather a large branch, springing from the posterior part of the plexus, generally from the third or fourth, leaves the pelvis through the lower part of the great sciatic notch, and, crossing the spine of the ischium, where it lies inferior to its artery, it again re-enters it through the lesser, to enter a triangular groove, bounded externally, by the tuber ischii and obturator internus; internally, by the obturator fascia; and inferiorly, by the falciform process of the great sciatic ligament, and here it divides into two branches, the dorsalis penis, and the perineal.

Dorsalis Penis, ascends through the anterior part of the ischio-rectal fossa, between the obturator internus, which is external to it, and the levator ani, which is internal to it; and on reaching the symphysis pubis, passes directly forwards, below the subpubic, and above the triangular ligament; it runs now along the dorsum of the penis, in company with its artery, but external to it; reaches the corona glandis, and sinking deeply between it and the corpora cavernosa, divides into numerous filaments, which perforate the spongy structure of the glans, and can be traced to the papillæ on its surface; about the middle of the penis, it throws off a large cutaneous

branch, which, after distributing several twigs to the integuments of its sides and dorsum, continues its course forwards, and is finally lost in supplying the folds of the prepuce.

Perinæal Branch.—Much larger than the preceding, lies at first inferior to the pudic artery, but afterwards ascends above it, and, running forwards, towards the superior and anterior part of the tuber ischii, divides into three branches—a superficial external, a superficial internal, and a bulbo-urethral.

Superficial External (*Long Perinæal*), passes at first downwards, perforating the falciform process of the great sciatic ligament, then winds forwards and upwards on the crus penis, and, becoming cutaneous, terminates in supplying the dartoid structure and integuments of the scrotum in the male, and the labia majora in the female; in its course, it always gives off a branch to the verge of the anus.

Superficial Internal (*Long Perinæal*).—Larger than the last, pierces the obturator fascia in company with the long perinæal artery, and, crossing the triangular space between the urethral muscles, reaches the scrotum, to the integuments of the central region of which it is distributed; several long filaments are likewise prolonged to the under surface and sides of the penis, which extend even as far as the prepuce.

Bulbo-urethral.—A thick, short branch, which also perforates the obturator fascia and base of the triangular ligament, and crossing upwards beneath the accelerator urinæ, is distributed to the bulb and corpus spongiosum. In the female, the pudic nerve gives off numerous branches to the vagina, which generally proceed as far as its external orifice.

Inferior Glutæal, arises from the back part of the plexus, and leaves the pelvis, through the great sciatic notch, below the pyriformis, and behind the great ischiatic nerve. While beneath the glutæus maximus, it divides into two sets of branches—muscular, and cutaneous: the former of which, breaking up into numerous twigs, is distributed to the glutæus maximus; while the latter, passing at first downwards, and then emerging from beneath its inferior margin, again winds upwards, dividing into two portions, which supply the integuments over it by long and slender filaments.

Lesser Sciatic, arises in common with the last, and passes out of the pelvis in company with it, and with the same relations. Beneath the glutæus maximus, it divides also into two branches—muscular, and cutaneous: the former, distributed to the origin of the hamstring muscles, and rotators outwards; while the latter, likewise emerging from beneath the edge of the glutæus maximus, again subdivides into two—an external or femoral, and an internal or perinæo-

scrotal, or long pudendal nerve of Soemmerring; the first, or femoral, desceuds on the inner side of the thigh, and becoming subcutaneous, supplies the integuments of that region, while the latter, or perinæo-scrotal, running forwards and inwards, aud crossing the tuber ischii, reaches the perinæum, where it lies between the layers of the superficial fascia; here it anastomoses freely with the long perinæal of the pudic, and continuing its course to the back part of the scrotum, divides into two branches, one of which runs forwards external, and the other internal, to the testicle, and uniting in front of it, they form a loop, from which numerous filaments are distributed to the dartoid structure, septum, and skin of the front of the scrotum.

Posterior Cutaneous, may arise either separately from the plexus, or from the greater or lesser sciatic, or from the inferior glutæal; it is always of small size, and leaves the pelvis by the great sciatic notch, below the pyriformis, when it runs nearly vertically downwards, beneath the glutæus maximus, and becomiug cutaneous in the upper third of the thigh, distributes numerous filaments to the integuments of that region; its terminal twig may be traced over the popliteal space to the back of the leg, where it unites with the cxternal saphenous, but in many iustances it may be followed still lower, even as far as the back part of the malleolus.

In order to avoid any confusion that might arise on this subject, we consider it proper to state that the threc last mentioned nerves are sometimes described under one name—the inferior glutæal, and in this case the posterior cutaneous and lesser sciatic must, of course, be considered as its dependent offsets.

Great Sciatic.—The largcst nerve in the whole body is formed not only by the four sacral uerves, but also by the communicating branch from the lumbro-sacral. It leaves the pelvis by the great sciatic notch, below the pyriformis; or, it may occasionally emerge in two divisions, one of which will piercc that muscle, while the other will pass out bcucath it, and descending almost vertically downwards, until it reaches thc upper part of the poplitæal space, divides into two branchcs: an external, the smaller,—the peronæal; and an internal, much larger,—the poplitæal. In its course along the back part of the thigh, it rcsts on the small rotators outwards, betwecn the tubcrosity of the ischium and great trochanter, covered by thc glutæus maximus; but farther down, it lies on the adductor magnus, and beneath the hamstring muscles, supplying, as it descends, the adductor, thc semitendinosus, semimcmbranosus, and biceps, and being throughout invested by a quantity of finc adipose areolar tissuc.

Poplitæal, or *Postcrior Tibial.*—Both from its size and direc-

tion, must be considered as the continuation of the great sciatic; it runs downwards, almost vertically, immediately beneath the fascia of the popliteal space, enveloped in fat, and then under the heads of the gastrocnemius, through the intercondyloid space, lying at first external to its artery, and then crossing it obliquely so as to reach its inner side; passing now over the poplitæus muscle, it descends between the heads of the soleus, and recrossing the posterior tibial artery in the upper third of the leg, so as to lie external to it, continues its course along the internal side of the tendo-Achillis, to the space between the os calcis and internal malleolus, where it divides into external, and internal plantar; having however, recrossed to the inner side of the artery previous to its division, but separated from it by one of the venæ comites.

The Internal Plantar, the larger of the two terminal branches of the poplitæal, runs at first downwards and forwards, till it reaches the groove beneath the os calcis, where it throws off a branch for the supply of the integuments of the heel, and then enveloped in a sheath of dense fibrous tissue, continuing its course forwards and inwards, between the first and second layers of the plantar muscles as far as the posterior extremities of the metatarsal bones, it divides into four branches, which are distributed in the following manner:—The first, or most internal, to the inner side of the great toe; the second, to the cleft between the first and second toes, where it divides into two, to supply their opposite surfaces: the third to the cleft between the second and third toes, where a similar division also takes place for their opposed sides; while the fourth, runs to the cleft between the third and fourth, supplying their adjacent surfaces in the same manner, and generally throwing off an anastomotic twig to the external plantar. In addition to those digital branches, it also gives filaments to the contiguous muscles, several to the skin on the inner side of the sole of the foot, and others to the articulations in its vicinity.

The *External Plantar Nerve*, much smaller than the internal, crosses the foot obliquely forwards and outwards, also in a dense fibrous canal, between the flexor digitorum brevis and musculus accessorius, then turns forwards between the flexor digitorum brevis and flexor minimi digiti, and at the base of the metatarsal bone of the little toe, divides into two branches,—a superficial, and a deep: the former, continues its course forwards, and subdividing into two, the most external is distributed to the outer side of the lesser toe, while the internal, on reaching the cleft between the fourth and fifth, also divides into two, for the supply of their opposed surfaces: the latter, or deep branch, accompanies the external plantar artery, sinking deeply beneath the three first layers of the plantar muscles,

and throwing off branches to the adductor pollicis, transversus pedis, lumbricales, interossei, and musculus accessorius, with a few articular filaments.

While in the popliteal space, the posterior tibial nerve gives off three twigs to the joint, viz., superior and inferior articular, and azygos; these accompany the arteries of the same name, supplying the inner and posterior part of the articulation. It also here throws off a remarkable branch,—the communicans tibialis, which, passing downwards and outwards at first beneath the fascia, and then between the heads of the gastrocnemius, unites at variable distances on the back of the leg, with a small twig from the peronæal,—communicans peronæi; their junction constituting the posterior or external saphenous nerve, which descends, in company with its corresponding vein, in a fibrous canal behind the external malleolus, supplying at this point the integuments on the outer side of the heel, and then arching forwards along the external aspect of the foot, to which it distributes numerous filaments, ultimately terminates on the outside of the lesser toe. The muscular branches which the posterior tibial gives off in this region are those to the gastrocnemius, soleus, and plantaris; but while on the back of the leg, it supplies all the deep muscles, besides distributing several cutaneous filaments to the investing integument.

Peronæal Division, much smaller than the Poplitæal; immediately after its origin from the sciatic it runs downwards and outwards, parallel but internal to the tendon of the biceps, and over the outer head of the gastrocnemius, next winds round the neck of the fibula, and beneath the peronæus longus, where it divides into its two terminal branches of nearly the same size, the anterior tibial and musculo-cutaneous, having, however, previously given off some filaments to the tibialis anticus, as well as a cutaneous branch for the supply of the skin on the outer part of the leg, and also the communicans peronæi, to unite with the communicans tibialis, for the formation of the posterior, or external saphenous, already described.

Anterior Tibial.—This nerve, immediately after its origin, receives a branch of communication from the posterior tibial, when it passes forwards and inwards, sometimes through, and sometimes beneath the extensor communis, and thus reaches its corresponding artery, to which it at first lies external, then anterior, and ultimately internal, supplying freely in its course the several muscles between which it runs; passing now beneath the annular ligament, in the sheath of the extensor pollicis it divides into two branches, an internal and external; the former, the larger, gliding beneath the dorsalis pollicis artery, and over the first interosseous space, again subdivides into two, one of which is distributed to the inner side of the

great toe, while the other bifurcates at the first interosseal space to supply the opposed surfaces of the first and second toes, at the same time freely communicating with the musculo-cutaneous nerve; the external branch, passes almost directly outwards, between the tarsus and extensor brevis, and is expanded in supplying that muscle as well as the interossei.

Musculo-cutaneous, the second division of the peronæal nerve, descends almost vertically between the extensor communis and peronæus longus, and piercing the fascia about two inches above the ankle-joint, where it becomes subcutaneous, divides into two branches —an external, and internal; these pass over the annular ligament, and reaching the dorsum of the foot, the external divides into three branches, each of which bifurcates at the cleft between the toes; the outer, at that between the fourth and fifth; the middle, at that between the third and fourth; and the internal, at that between the second and third; these secondary branches supplying the skin, on the dorsum and sides of the opposed surfaces, of each of the corresponding toes; while the internal division of the musculo-cutaneous, on the contrary, usually continues as a single trunk to the cleft between the first and second toes, and there bifurcating, is distributed to their adjacent surfaces. This is the most usual course observed in the distribution of this nerve, but at the same time it must be remarked, that it is subject to several varieties in its ultimate ramifications.

The musculo-cutaneous nerve, while in the leg, gives off two or three filaments to the peronæus longus, and one or two to the integuments over the external malleolus; it likewise freely communicates in the foot with both saphenæ.

POSTERIOR SPINAL NERVES.

First Cervical.—Is larger than the anterior branch, and after its exit from the foramen of conjugation, passes backwards and inwards between the posterior half-arch of the atlas and vertebral artery, presenting here a kind of gangliform enlargement; entering now into the triangular space, between the obliqui and rectus, it divides into several filaments for the supply of those muscles and the complexus; it also communicates with the second.

Second Cervical.—Remarkable for its great size, being nearly four times larger than its anterior branch; escapes between the atlas and axis, and throws off communicating twigs to the first and third nerves; passes upwards, over the inferior oblique and the triangular space, covered by the complexus, which it afterwards perforates very obliquely; between the complexus muscle and the trapezius, it joins but at the same time lies internal to, the occipital artery, and then

piercing the trapezius, and becoming subcutaneous, divides into a series of branches of a flattened form, which are distributed exclusively to the scalp, and hair follicles of the occipital region. While in the neck it gives off large branches to the inferior oblique, splenius, complexus, and trapezius.

THIRD CERVICAL, much smaller than the second, emerges between the axis and third cervical vertebra, and immediately sends off an anastomotic twig to the second; it now continues its course inwards, between the semispinalis colli and complexus, and at the internal border of the complexus, divides into two branches, a cranial and a cervical, both cutaneous; the former, perforates the attachments of the complexus and trapezius to the spinous processes, and is distributed to the integuments of the mesial line of the occipital region; while the latter, also piercing the same muscles, is immediately reflected outwards for the supply of the skin immediately over them. The anastomosis which we have mentioned between the three nerves just described constitutes what has been called the posterior cervical plexus, which lies between the complexus and semispinalis colli, in company with the posterior jugular vein, and cervicalis profund artery. Its branches of supply are distributed to the complexus, the semispinalis colli and the splenius.

It would be tedious, as well as unnecessary, to describe individually the posterior branches of the five remaining cervical nerves, as their course and ultimate distribution are almost precisely similar, running at first inwards, between the complexus and semispinalis colli, to each of which they give muscular branches, as well as to the multifidus spinæ, and then perforating the superimposed muscles, are distributed to the integument on the posterior part of the neck.

The posterior branches of the eight first dorsal nerves, may be likewise described in conjunction, as they are all very similar in their course and distribution, but much smaller than the same branches of the posterior cervical. After their separation from the anterior, each posterior dorsal nerve passes almost directly backwards, in company with the vein and artery, through a quadrilateral space, bounded above and below, by the transverse processes of the contiguous vertebræ; internally, by the intervertebral substance; and externally, by the anterior costo-transverse ligament; and on reaching the outer border of the semispinalis dorsi, divides into two sets of branches—muscular, and cutaneous; the former, supplying the levatores costarum and erectors of the spine, while the latter, after distributing some twigs to the semispinalis dorsi, wind backwards and inwards over its superficial surface, until they arrive at the spinous processes, where, piercing the aponeurosis of the latissimus dorsi, they are again reflected forwards between it and the trapezius, which they

perforate, become subcutaneous, and are distributed to the skin of the thorax, in broad, ribbon-like branches. The posterior divisions of the four last dorsal, are very similar to the preceding, but their muscular branch is very small, and is distributed almost exclusively to the multifidus spinæ; while the cutaneous passing backwards through the muscular fibres of the erectors of the spine, which they very freely supply, next perforate the aponeurosis of the transversalis, internal oblique, and latissimus dorsi, and becoming subcutaneous, divide into external and internal branches, the former passing almost vertically downwards, and supplying the integuments as low as the glutæal region, while the latter winds inwards towards the spine, to be distributed to the skin in that position.

Posterior Lumbar Branches, gradually decrease in size from above downwards, and, like the dorsal, are expended in supplying the lumbar mass of muscles, and the integuments over them.

Posterior Sacral, like the last, decrease in size from above downwards, and on emerging from the sacral foramina, freely communicate with each other, and then divide into branches to supply the adjacent muscles, as well as the integument over the sacral and glutæal regions.

SYMPATHETIC SYSTEM

Presides over the functions of organic life, and consists of two long knotted cords, stretching along either side of the spinal column, from the base of the cranium above, to the coccyx below, where they are fused into a common mass, termed the ganglion impar. In order to understand this system properly, it will be necessary to divide it into a cervical, thoracic, abdominal, and sacral portion; to examine its ganglia in each of those regions, and briefly describe the branches which it supplies, with the various plexuses that it forms in the course of its long descent.

Cervical Portion, consists of three ganglia—superior, middle, and inferior, which are connected to each other by an intervening nervous communication, rendering them perfectly continuous with each other.

Superior Ganglion, is fusiform in shape, of a greyish-pink colour, and in length varying from one to four inches; its upper extremity being situated about three-quarters of an inch from the carotid foramen, while its inferior, which is sometimes bifid, gives off the branch to the middle. It usually corresponds posteriorly, to the second and third cervical vertebræ, and is covered by the internal carotid artery, pneumogastric, glosso-pharyngeal, and lingual nerves, while the internal jugular vein lies posterior and external to it. The branches

which it throws off have been divided into superior, inferior, external, internal, and anterior; and these we now propose to examine in order.

Superior Branch, proceeds upwards, from the summit of the ganglion, and entering the carotid canal, divides into two, which run on the inside and outside of the artery, presenting at the first turn an enlargement described as the carotid ganglion (Lobstein); a little farther on, it communicates with the Vidian, as the latter perforates the cartilage which fills the anterior lacerated hole, as well as with the nerve of Jacobson, from the tympanic plexus, and on entering the cavernous sinus, it anastomoses by several filaments, with the sixth nerve. From the plexus formed in this last situation, two twigs are given off which accompany the anterior cerebral artery as far as the arteria communicans, on which they unite to form the ganglion of Ribes, the existence of which may be considered fairly questionable; while in the cavernous sinus it likewise communicates with the third, Casserian, and lenticular ganglions, and it also sends off branches to the pituitary body, with others to accompany the ultimate divisions of the internal carotid, around which they form complicated plexuses.

Inferior Branch, consists of a fine tapering cord, which descends behind the sheath of the vessels, to which it is connected by fine areolar tissue, as far as the inferior thyroid artery, where it joins the middle, or, when that has no existence, continuing its descent as far as the inferior ganglion. In its course, it communicates by one or two twigs, with the cervical plexus; also with the superior cardiac, and superior laryngeal.

External Branches, pass backwards, to unite with the first and second cervical, but particularly with the latter, a distinct twig being sometimes given to the phrenic.

Internal Branches, may be divided into a vascular, and visceral; the former, accompanying the external carotid, around the branches of which it forms numerous plexuses and minute ganglia; while the latter or visceral, may be again subdivided into pharyngeal, laryngeal, and cardiac—the first, uniting with the branches of the glosso-pharyngeal and pneumogastric, to form the pharyngeal plexus, for the supply of the muscles of the pharynx; the second, communicating with the superior laryngeal, for the supply of the larynx; while the third, is destined for the heart, and will presently be more particularly described.

Anterior Branches, consist of short thick branches of communication to the eighth nerve; filaments are also occasionally given to the ninth, but are not always capable of demonstration.

Middle Cervical Ganglion, may be sometimes absent, but when

it does exist, it is found opposite the fourth or fifth cervical vertebra, resting on the inferior thyroid artery, or sometimes behind it. According to our observation, it is diamond-shaped in figure, its long measurement being from above downwards, throwing off branches from each of its angles, viz., superior, inferior, internal, and external.

Superior Branch.—Merely the cord of communication, already de-described, between the two ganglions; it generally becomes expanded as it joins the middle.

Inferior Branch.—May be either single, or it may consist of several, which descend to connect it to the inferior ganglion.

External.—Twigs of communication to the cervical plexus, one of which usually joins the phrenic directly.

Internal Branch.—Cardiac, to be hereafter described.

Inferior Cervical Ganglion.—Small and semilunar in figure, with its concavity directed upwards and forwards, its convexity downwards and backwards, rests upon the transverse process of the seventh cervical vertebra, covered by the vertebral artery, which it sometimes surrounds almost completely. Its internal cornu receives the communicating twig from the middle, while its external throws off filaments to the brachial plexus, and also a branch to the vertebral artery, as it ascends through the foramina of the transverse processes, which communicates in its course with the superior cervical nerves, and ultimately enters the cranium, forming plexuses to accompany the ramifications of the basilar artery, as it supplies the cerebrum and cerebellum; branches are also thrown off from the lower, or convex, margin of the ganglion, to unite with the first thoracic, and recurrent nerve; and some of these passing in front, and others behind the subclavian artery, invest it with a sort of nerve-ring (annulus of Vieussens).

Cardiac Nerves, are three in number on each side, superior, middle, and inferior, and are destined for the supply of the heart.

Superior Cardiac Nerve, arises from the front of the superior cervical ganglion, by five or six filaments, which unite into one cord after receiving a twig from the second cervical nerve on the *right* side; it now descends close to the trachea, external and posterior to the common carotid, sending filaments to the thyroid gland, pharyngeal plexus, and pneumogastric nerve, and at the lower part of the neck winds outwards, crossing between the subclavian vein and artery, and behind the middle cardiac, and here divides into filaments, which unite with others from the recurrents, and inferior cardiac. The nerve of the *left* side, pursues nearly a similar course, but at the lower part of the neck it passes between the subclavian and carotid arteries, and at their origin divides into numerous branches.

some of which run along the aorta, to unite with the inferior cardiac, while others pass behind it, to join the cardiac ganglion.

Middle Cardiac Nerves.—Usually very large, arise from the inner side of the middle cervical ganglion, by five or six roots, which soon unite to form a single trunk; after communicating, by two or three filaments, with the pneumogastric, the *right* nerve descends between the subclavian vein and artery, anastomosing with the recurrent; it next passes downwards, on the outside of the arteria innominata, and then passes between the arch of the aorta and bifurcation of the trachea, where it expands to form the cardiac ganglion. The nerve of the *left* side is not as large as the preceding at its origin, but it receives a reinforcing branch from the inferior cervical ganglion, as well as two or three twigs from the pneumogastric, and then passing behind the arch of the aorta, terminates in the cardiac ganglion.

Inferior Cardiac Nerves, arise from the inferior cervical ganglions, by numerous filaments, which afterwards unite, and then pass downwards, behind the subclavian artery on the *right* side, and along the side of the pulmonary artery on the *left;* both terminate in the cardiac plexus, on the front of the trachea, and behind the aorta.

Cardiac Ganglion, was first noticed by Wrisberg, who described it as lying between the concavity of the arch of the aorta, and right pulmonary artery; it is formed, according to the same author, by communicating filaments of the right and left cardiac nerves, with twigs from the pneumogastric. It must, however, be confessed, that the most careful dissection will sometimes fail in discovering it.

Cardiac Plexus.—Formed in a great measure by the middle and inferior cardiac, but likewise receiving some filaments from the superior, and usually displaying a ganglionic enlargement at its formation; it rests upon the front of the trachea, immediately behind the transverse portion of the arch of the aorta, and above the right pulmonary artery.

The distribution of those nerves to the heart, and great vessels, will be more clearly understood, by dividing them into three sets, namely, an anterior, middle, and posterior.

The Anterior Division, is very small, although receiving the filaments from the ganglion of Wrisberg, when present; it passes downwards, and to the right side of the arch of the aorta, reaches the right coronary artery, and there forms a plexus, which is situated on the upper part of the right ventricle, the branches of which are distributed to the walls of that cavity.

The Middle Division, is that portion usually known as the great cardiac plexus of Haller; it is very large, and some of its branches present ganglionic enlargements. Its position has been already de-

scribed as lying between the transverse portion of the arch of the aorta and trachea, but above the right pulmonary artery. It unites with the

Posterior Division, which rests in the bifurcation of the trachea, beneath the right pulmonary artery, below which, and on front of the auricles, it joins the middle division, throwing off branches to supply the walls of those cavities, while others, larger in size, course through the auriculo-ventricular grooves, forming the anterior and posterior coronary plexuses, for the supply of the ventricular portions of the heart.

Thoracic Ganglia.—The sympathetic, in the cavity of the thorax, consists of a long knotted cord, lying at each side of the bodies of the vertebræ; the ganglions which it presents, are twelve in number, and are nothing more than fusiform dilatations on it as it descends, being always connected together by neurine of analogous character to the cord itself. These ganglia are situated on the head of each corresponding rib, and on the intercostal artery and vein, and are covered by the pleura, and subjacent fibrous tissue. The branches which they throw off may be divided into external, and internal.

External Branches, are filaments of communication from each ganglion to each corresponding dorsal nerve; they are always two in number, one springing from its external angle, and the other from its deep surface.

Internal Branches, may be divided into thoracic, and abdominal: the former, being distributed, by several fine filaments, to the aorta, to the pulmonary and cardiac plexuses, and, according to one very high authority, to the bodies of the vertebræ; while the latter, consist of the greater, and lesser, splanchnic nerves.

Great Splanchnic Nerve, arises generally from the sixth ganglion, but it may come off higher up, and the cord which it forms receives in succession filaments from the seventh, eighth, ninth, and tenth, which join it at a very acute angle. On reaching the lower part of the thorax, the nerve thus formed becomes flattened, and, piercing the crus of the diaphragm, enters the abdomen, where it expands into a body called the *semilunar ganglion*, of the figure implied by the name, having its convexity, which is serrated, and which give off numerous branches from each tooth-like process, turned downwards and outwards; and its concavity, from which likewise numerous branches, presenting several minute ganglia, and with those of the opposite side surrounding completely the cœliac axis, so as to constitute the *solar plexus*, are thrown off, directed upwards and inwards. Each semilunar ganglion, rests on its corresponding crus, and is partially overlapped by the suprarenal capsules, which are, however, a little external to them; but the vena cava almost completely covers the right.

while the solar plexus is supported by the abdominal aorta, and has in front of it, the ascending layer of the transverse mesocolon; this great plexus receives filaments from the right pneumogastric, occasionally also some from the phrenic; and it has a quantity of loose areolar tissue, mingled up in its formation with numerous small lymphatic glands. The plexuses which are derived from it are:—1. Diaphragmatic, which accompany the phrenic arteries for the supply of that muscle, the right plexus being always larger than the left. 2. Capsular, comparatively large, for the supply of the supra-renal capsules. 3. Hepatic, consisting of two distinct plexuses, one anterior, accompanying the artery,—the other posterior, following the vena porta, for the supply of the liver; they also send a number of twigs to the gall-bladder. 4. Splenic, comparatively small for that organ. 5. Coronary, for the stomach, principally to its upper curvature. 6. Renal, which unite with the lesser splanchnic, presently to be described, for the kidney and spermatic cord; and ovaries, in the female. 7. Superior mesenteric, which accompanies the artery of the same name, for the supply of the small intestine, and right portion of the large. 8. Inferior mesenteric; it likewise follows its corresponding artery, and is distributed with it to the remaining part of the large intestines, communicating in the pelvis with the hypogastric.

Lesser Splanchnic Nerve, arises from the tenth and eleventh dorsal ganglia, and forms a small cord, which perforates the outer edge of the crus of the diaphragm, and passing downwards to the hylus of the kidney, unites with branches of the greater, to constitute the *renal plexus* for the supply of the kidney; it gives off the *spermatic plexus*, to the testicles in the male, and the ovaries in the female; and the *hypogastric*, which is distributed to the bladder, and rectum.

Lumbar Ganglions, are five in number, and generally of a fusiform shape; but the superior especially, are occasionally so blended together, that it is impossible to assign any particular figure to them. They are connected to each other, by slender cord-like branches, sometimes double, forming a chain on either side of the vertebral column, internal to the origin of the psoas. The branches which they give off may be divided into external, and internal; the former, pass downwards and outwards, in company with the lumbar arteries, between the loops of origin of the psoas, to join the lumbar plexus, in the body of that muscle; but there is always a great want of uniformity in their arrangement, as several twigs may pass off from the ganglions above, and none from those below; the latter, or internal branches are exceedingly numerous; they spread out on the aorta, forming around it, a complicated plexus, interspersed with numerous ganglia, and they likewise give off several filaments to the

plexuses derived from the solar, as well as to the hypogastric, to which allusion will presently be made.

Sacral Ganglia.—Always irregular as to number, varying from three to five; they lie along each side of the sacrum, over the anterior sacral foramina, and covered by peritonæum, and loose areolar tissue; they communicate above, with the last lumbar, by a cord which is generally multiple; while below, those of opposite sides unite in an arch, convex downward, on which a fusiform dilatation is often present (ganglion impar). Its branches consist of external, internal, and anterior.

External Branches.—Filaments of communication, to the nerves of the sacral plexus.

Internal Branches, unite with each other, on the front of the sacrum, forming a plexus around the middle sacral artery.

Anterior Branches, join with those of the lumbar ganglia, with the mesenteric plexus, and with those of the vesical, and hæmorrhoidal, in the male; and with the uterine, and vaginal, in the female; the four last being from the sacral plexus—the complicated network formed by all these constitute the hypogastric plexus, which lies on the sides of the bladder and rectum, from which smaller plexuses are derived, viz. the vesical, hæmorrhoidal, uterine, and vaginal, for the supply of their proper organs.

ORGANS OF SPECIAL SENSE.

The special senses are five in number, namely, Touch, Sight, Hearing, Smelling, and Taste, the three first of which will be described in the present section, with the skin, eye, and ear; the two latter having already been examined with the Anatomy of the Nose and Tongue.

THE SKIN.

The skin, or tegumentary covering of the body, is a compound of an epithelial surface layer, supported on a basement membrane, and united to the subjacent parts by areolar tissue. We will first examine the anatomical elements of the integument, and then describe its function and peculiarities, taking them in the following order:—Cuticle, rete mucosum, corpus papillare, and the cutis vera, or dermis—these constituents being analogous to those of the mucous membrane, the two tissues being, in fact, continuous at the great outlets of the body.

Cuticle.—This horny layer of the integument, forms a continuous covering for the sensitive surface of the subjacent cutis, and consists of scales, which overlapping each other, produce intervening ridges

that observe a waving or concentric disposition, particularly well marked at the extremities of the fingers. When minutely examined with a lens, funnel-shaped openings are visible on these ridges, indicating the orifices of the sudoriferous glands, and sebaceous follicles, together with the apertures through which the hairs are evolved. The surface may be also observed to be divided into small, square, or lozenge-shaped elevated spaces, in consequence of the projections caused by the papillæ of the cutis. When a portion of the cuticle is raised by maceration, the deep surface appears soft, and impressed by the papillæ, with elongated processes which sink into the hair follicles, sudoriferous and sebaceous glands, and if a portion is scraped off it will be found to consist of cells containing pigment granules, as if they were the scales of the cuticle, in an immature condition.

The cuticle is composed of albumen, and differs remarkably in density in different parts of the body; thus, on the palms of the hands and soles of the feet, glutæal region, scalp, and back, it is thick; while on the face, eyelids, penis, points of the fingers, and front of the body generally, it is fine and comparatively smooth. Neither nerves, nor vessels, have been traced into its structure, which is therefore, like the nails and hair, without any distinct organization. Breschet conceived that special glands, of a reddish colour, and exceedingly small, situated in the subcutaneous fatty tissue, secreted the cuticle; but such glands are not present, and it is more just to regard it as a cell growth, evolved by the superficial surface of the cutis; and, in conformity with this view, we find that the deep surface of the cuticle consists of granular cells, and the nearer the superficial aspect is approached, the more the cell character disappears, being replaced by scales, which still, however, present a trace of their former nuclei.

Rete Mucosum, consists of immature epidermic corpuscles, containing iron, or carbon, phosphate of lime, and animal matter, as pigment granules. This layer is black in the negro, and of a fawn colour in the European, being well marked in the latter in the perinæum, scrotum, neighbourhood of the anus, and around the nipple of the pregnant female. Breschet conceived, but without any foundation for such a supposition, that there were also several glands for the secretion of this structure, situated in the cutis vera.

Cutis Vera, is composed of an elastic membranous layer, having two surfaces,—the superficial being irregular, but smooth, constituting the papillary layer; while the deeper, although dense where it approaches the surface, becomes gradually more lax inferiorly, where it is blended by irregular prolongations with the subcutaneous areolar tissue.

The Tactile Papillary Layer, exists on the whole external surface of the cutis; but the number and size of the papillæ predominate in those situations where tactile sensibility is at its maximum, for example, at the extremities of the fingers, on the tongue, palm of the hand, and soles of the feet, being usually developed in an inverse ratio to the thickness of the subjacent cutis. The surface presents furrows, which pursue various directions, separated by intervening ridges, which may be curved, tortuous, or concentric, indicating the disposition of the tactile organ. The ridges, result from a single or double row of conical processes or papillæ, which project from the surface of the cutis, the papillæ being arranged in pairs, with shallow surface grooves indicating the spaces between them, and passing transversely to the long axis of the ridges; while in the midde of the linear elevation, a dark point defines the opening of the sudoriferous duct. The papillæ, are often of unequal size in the same ridge, but their average length is about $\frac{1}{100}$th of an inch, and the diameter at the base about $\frac{1}{250}$th. Their outline is well defined, when viewed with a power of 500, and they appear semi-transparent, flexible, and if not very forcibly bent, returning to their former position, signifying a certain amount of elastic property, although apparently homogeneous. A vertical set of lines seem to imply a fibrous organization, which, with two or three capillary loops, and a single nervous one (Gerber), completes the structure of the papilla. Messrs. Todd and Bowman, in their *Physiology of Man*, state, that they have not been able to detect the nervous loops, but have seen a single tubule entering the papilla, and then becoming lost to view. (See page 412 of the above work, which is equally explicit and simple on the skin, as on all other parts of structural anatomy.)

Corium.—This term has been applied to that portion of the cutis lying beneath the papillary layer. It is soft, flexible, and elastic, consisting of white and yellow fibrous tissue; the latter predominating where elasticity prevails, and the former where resistance and fixedness are requisite, as in the palms of the hands, and soles of the feet. This layer is thickest on the back, sides of the body, and scalp, but fine and thin over the flexures of joints, and dense on the palms of the hands, and soles of the feet; its deep surface is rough and filamentous in all situations, and attached to the subjacent areolar tissue. It is composed of gelatine, which may be extracted by boiling, while maceration in solutions containing tannic acid, converts it into leather.

Appendages of the Skin.—These consist of the sudoriferous and sebaceous glands, the hairs, and nails.

Sudoriferous Glands, are of a follicular type, one extremity

lying in the subcutaneous areolar tissue, and the other free. Each gland consists of a single tube, which is closed at the deep extremity, and intricately coiled on itself, so as to form a small round mass from which the efferent tube passes, in a tortuous course through the cutis, until it arrives at the papillæ, where it becomes straight, then closely spiral as it pierces the cuticle, and terminates on the surface by an oblique and expanded orifice. Each tube, the cavity of which is about $\frac{1}{1700}$th of an inch in diameter, possesses an external basement layer, which becomes continuous with the papilla, and a lining of epithelium derived from the cuticle.

These glands are situated in the subcutaneous areolar tissue, and their number is in proportion to the amount of sweat secreted by the part, being present on every part of the surface, but most numerous in the axilla, perinæum, and folds of the nates.

Sebaceous Glands, are also follicular, consisting of a mere tube, occasionally branched, which becomes pouched or convoluted in the substance of the cutis, and sometimes projecting into the areolar tissue, while the efferent tube either opens into the hair follicle, or on the free surface. They are most numerous on the face, scrotum, and perinæum, while they are absent on the palms of the hands, and soles of the feet. The coats of the ducts are similar to, but finer than, those of the sudoriferous glands, and within them may be usually found the peculiar parasite known as the *entozoon folliculorum*. Their use is to secrete an oleaginous fluid, which lubricates the surface of the skin.

Hairs.—This superficial appendage to the skin, is strewed over the whole surface, with a very few exceptions; whilst in some localities it is concentrated, so as to form a covering, more or less thick, and in situations so obvious that we do not conceive it necessary to mention them. The root, or hair bulb, is that expanded portion about twice the diameter of the hair itself, which is set in the follicle, and is always excavated at its base; the hair follicle, is a depression in the dermis, extending deeper into the areolar tissue than either those of the sudoriferous glands, or sebaceous follicles, and is formed by an invagination of the cuticle; but between it and the root, an interval exists, filled with a reddish fluid, into which the sebaceous follicles open, and in which entozoa are frequently generated. The shaft of the hair consists—first, of a scabrous coat, continuous with the cuticle, the scales overlapping from the fixed to the free extremity; and more internally, a fibrous stratum, while in the middle there is a medullary or cell structure, containing the colouring matter, which is altogether deficient in the albino; and which, in black, red, and yellow hair, is composed respectively of peroxide of manganese, oxide of iron, and sulphur. The stem, elongated, and more or less cylin-

drical in form, differs however from a perfect cylinder, in being laterally compressed or reniform, and is also thicker at the junction of the middle and inferior third, than at the extremity, where hairs are generally split, or bifurcated. The size of the hairs varies in different parts of the body, those of the head being the longest, those on the general surface the finest (lanugo), and those of the pubis, whiskers, chin, and axilla, the strongest.

The Use of the Hair.—On the head, it is esteemed as an ornament; on the cheeks and face it gives character and expression to the countenance; and on the pubis and genitals, it serves for the purpose of concealment (Hassal).

The NAILS, are twenty in number, and rest on the posterior surface of the distal extremity, of each finger and toe. Each nail is convex from side to side, and also in the antero-posterior direction, the posterior and the lateral margins being imbedded in a groove in the dermis, whilst the nail itself is merely a continuation of the scaly cuticle. The superficial surface is smooth, but linear, in consequence of the formative cells being arranged in rows from before backwards; and if the nail is torn from the matrix, nucleated cells containing pigment granules will be seen on its deep surface; at the posterior extremity a white semilunar space exists, named the lunula, beneath which, the matrix is not as vascular as in other situations. The matrix, is highly organized, and studded with papillæ, which are linear from before backwards, and imbedded between those of the nail itself, thus adding to the closeness of their connexion. The nail grows in two directions—first, from behind, by the constant evolution of new cells; and secondly, by the deep surface, the papillæ producing new laminæ beneath, as is frequently observed in diseased toe nails. When the nail is destroyed, it is usually regenerated, and the whole extent would be developed in three months, if the computation that it would grow $\frac{1}{30}$th of an inch, each week, is correct; but experience has taught us that the period laid down for its full regeneration is much too short, and should be extended to nearly six months.

The skin is of use, in conferring symmetry on the body, preventing too rapid evaporation, and defending the subjacent parts from injury, by acting as a sentinel. The functions of exhalation, absorption, with the sense of touch, have likewise their seat in this tissue.

THE ORBIT.

In order to dissect this cavity, the subject should be turned on the face, and raised to a convenient height by a block placed beneath the chest; a second block, with an excavation superiorly, should now be

fixed beneath the chin, so as to retain the skull in an almost erect position, and then a cut should be made with a saw, through the roof of the orbit, about a line and a half external to the internal angular process of the os frontis; and a second, through the external angular process of the same bone, both converging behind, to meet at the sphenoidal fissure; however, the ring of bone, bounding the optic foramen above, may be left entire, by running the saw lightly across, about two lines anterior to the anterior clinoid process, when a few light blows of a hammer will now throw the bone forward.

The orbit contains the globe of the eye, with its muscles, nerves, arteries, lachrymal gland, absorbents, veins, and a quantity of adeps, which occupying the interstices between the muscles, forms a soft and yielding cushion for the support of the globe, but which gradually diminishes in old age and all emaciating diseases, a circumstance indicated by the recession of the eye within the orbit. When the piece of bone alluded to has been removed, the periosteal membrane may be observed.

Periosteum.—This dense white fibrous membrane enters the orbit both by the foramen opticum, and the sphenoidal fissure, and is a continuation of the dura mater, but differs from that structure in being weaker, and less intimately adherent to the bone. It lines the whole of the interior of the orbit, and passing forwards to the rim of the cavity, becomes continuous with the broad palpebral ligament, being much stronger posteriorly and internally, than anteriorly and externally; as the optic nerve enters, it sends a process around it which passes forwards, and becomes continuous with the sclerotic coat, while superiorly, externally, and anteriorly, it splits to inclose the lachrymal gland, the outline of which is now also visible, as well as a horizontal groove running from before backwards, corresponding to the frontal nerve. If the periosteum is now cautiously raised, the following parts are brought into view from without inwards:—Lachrymal gland, nerve, and artery, lying on the upper edge of the external rectus muscle; more internally, a fatty interval, wider before than behind; still more internally, the frontal nerve, and its supratrochleator branch, lying on the levator palpebræ, while on the outer side of the latter, a small portion of the superior rectus muscle is seen; still more internally, a second fatty interval occurs, which is crossed in front, by the supra and infratrochleator nerves; and lastly, at the innermost part of the cavity, the superior oblique muscle, with the fourth nerve lying on its orbital aspect near its posterior part, is observed. The student should now turn to the description of the cerebral nerves, and may examine the frontal, lachrymal, and fourth, and subsequently the muscles as they appear.

Lachrymal Gland.—This conglomerate gland consists of two

portions—one large, occupying a fossa in the external angular process of the frontal bone (orbital portion), and the second smaller, situated between the conjunctiva and the upper lid (palpebral portion). The orbital portion, transversely oval and extremely variable in its outline, but usually equalling in size one-half of a hazel nut, corresponds above, to the bone with a layer of periosteum, and filaments of the lachrymal nerve; inferiorly and internally, to the external rectus, and the globe of the eye; anteriorly, to the superior palpebral ligament, so that when enlarged it projects through the upper eyelid; and posteriorly, to the lachrymal vessels and nerve. The palpebral portion, is usually caudate and flat, being granular or finely lobulated in its structure, with a dense process of the periosteum investing its surface, and sending processes into its tissue, and rests on the superior rectus, levator palpebræ, and upper eyelid. The ducts of the gland, about from twelve to sixteen in number, open on the superior palpebral sinus, and pour their contents over the free surface of the globe of the eye for the purpose of lubrication.

Muscles of the Orbit, consist of the levator palpebræ superioris, the superior and inferior oblique, and the four recti—the superior, inferior, internal, and external.

Levator Palpebræ Superioris.—Triangular in figure, with the apex behind, and base anteriorly; arises from the upper margin of the optic foramen, and the frontal bone in front of that opening; it passes forwards and upwards, becoming gradually wide and fleshy, and behind the edge of the orbit forms an aponeurotic layer, which, curving downwards, is inserted into the superior margin of the tarsal cartilage, from which it is continued downwards, on the posterior surface, to its ciliary edge (Sir P. Crampton), into which it is inserted, as well as into the superior palpebral sinus, on the deep surface of the palpebral ligament.

Relations.—It is covered by the periosteum, by the frontal and fourth nerves, with the supratrochleator branch of the fourth, and by the upper lid; and it lies on the superior rectus, superior division of the third, and ocular fascia.

Action.—To elevate the upper eyelid, and thus, by admitting the advance of the globe, to depress the lower lid. Sir P. Crampton considered tonic contraction of this muscle to be the usual cause of entropium, and on this opinion his peculiar operation for that disease is founded.

Superior Oblique.—Situated at the internal part of the orbit, tendinous behind and in front, and fleshy in the middle, arises from the superior and internal part of the optic foramen, and forming a fusiform fleshy belly, runs upwards, inwards, and forwards, parallel to the os planum of the ethmoid bone; having reached the internal

canthus, it terminates in a round tendon, which plays through a fibro-cartilaginous, or sometimes an osseous pulley, at the inner angle of the frontal bone, from which it is separated by a bursa, where it expands, and turning downwards, backwards, and outwards, between the superior rectus and the globe, and piercing the ocular fascia, is inserted, by a silvery tendon, into the sclerotic coat, between the external and superior recti, behind the transverse axis of the globe of the eye.

Relations.—It is covered by the periosteum, fourth and supratrochleator nerves, with the superior rectus at its origin; and it lies on the internal rectus, nasal nerve, ocular fascia, and the sclerotic coat; as the tendon pierces the ocular fascia, a process of that membrane is prolonged on it, towards the trochlea, while a much finer tubule is sent on the ocular part of the tendon.

The levator palpebræ, and superior oblique, may be now cut in the middle, and inflected, in order to expose the recti.

Rectus Superior, or Attollens Oculi.—Tendinous anteriorly and posteriorly, fleshy in the middle, arises from the upper part of the optic foramen, and from the crest separating that opening from the sphenoidal fissure, as well as from the sheath of the optic nerve; it passes upwards, and forwards, and a little outwards, and soon becoming fleshy, runs above the optic nerve and globe of the eye, and about half-an-inch behind the cornea, forms a silvery tendon, three lines in width, which pierces the ocular fascia, by a prolonged aperture, but separated from the margins of the opening, by a fine membranous tissue like a bursal structure, and is ultimately inserted into the sclerotic coat, about four lines behind the cornea.

Relations.—It is covered by the levator palpebræ, by one branch of the superior division of the third, and at its insertion by the ocular fascia; and it lies on the optic nerve, superior division of the third, nasal and ciliary nerves, ophthalmic artery, ocular fascia, and the sclerotic coat.

The superior rectus should be now divided, and its two portions reflected, one backwards and the other forwards, when the following parts are seen as the second layer:—Internal rectus, with the proper nasal, and infratrochleator nerves lying on it; more externally, a fatty interval, crossed by the nasal nerve; then the optic, with the superior division of the third, and nasal resting on it, and on the outer side of the last the lenticular ganglion with its roots; and lastly, the external rectus, while the globe of the eye is still obscured by the ocular fascia, which structure may now be examined.

Ocular Fascia, or Tunica Vaginalis Oculi, which has been successively described by Tenon, Dalrymple, Malgaigne, and O'Ferrall, is a very distinct structure, forming a sheath or capsule for the

globe, derived posteriorly from the dura mater, as it surrounds the optic nerve, from which it passes forwards to be attached to the orbital margins of the tarsal cartilages, and consequently is conical in shape, with the base in front and the apex behind; tough, fibrous, and laminated, it presents for description an external and internal surface, the former supporting the muscles which surround the globe, and presenting six perforations, by which they enter to reach the sclerotic, namely, four for the recti, and two for the oblique muscles; but from the margins of the apertures a tubule is sent back on each, forming a complete sheath for the recti and inferior oblique, while on the superior oblique it passes only as far as the trochlea: it is likewise perforated by the optic and ciliary nerves, as well as by the ciliary vessels. If a tenaculum is introduced into its surface, layer after layer may be raised, and these are united to each other by fine areolar tissue; when divided longitudinally, its thickness will be observed to vary, being much stronger in front, but in that situation more loosely connected to the contained eye-ball. On drawing the divided margins asunder, the internal perforations for the muscles are seen, each tendon being surrounded by a fine glistening membrane, differing altogether from the structure of the vaginal tunic, while small thread-like filaments pass from the internal aspect of the capsule to the sclerotic, the surface of the latter being smooth, polished, and shining, like a serous tunic. Although probably premature, we may here state our opinion, that we believe the tunica vaginalis to consist of two layers, namely, tunica fibrosa and serosa, the latter being a distinct serous sac, resembling in its character the arachnoid membrane, in support of which opinion there are certain anatomical and physiological proofs, but these we reserve for the present.

This membrane prevents the undue pressure of the surrounding muscles on the eye, and likewise keeps the globe in contact with the lids; it also, according to Dr. O'Ferrall, alters the action of the recti by preventing their retracting the eye within the orbit, and making them act as if they arose from points of the orbit opposite their insertions; but the real use of the capsule, with its smooth and polished surface, would appear simply to be, to allow the globe to perform its short rotatory movement with greater ease and rapidity than if the organ moved on the fat at the back of the orbit.

External Rectus, or Abductor, lies on the outer wall of the orbit, and arises tendinous from the ligament of Zinn, and the ridge separating the optic foramen from the sphenoidal fissure; also from the base of that fissure by a narrow tendon, the two origins being separated by the third, nasal, sixth nerves, and the opthalmic vein; it then passes forwards and outwards, and forms a tendon, which

piercing the ocular fascia, is inserted into the sclerotic coat, from five to six lines behind the cornea.

Relations.—Externally, it corresponds to the outer wall of the orbit; and internally, to the sixth and third nerves, fat, lenticular ganglion, and its roots, ocular fascia, and sclerotic coat; the lachrymal nerve, and artery, course along its upper margin, and the lachrymal gland lies on it anteriorly.

INTERNAL RECTUS, or ADDUCTOR OCULI, is found on the inner side of the orbit, and arises from the ligament of Zinn, inner edge of the optic foramen, and occasionally from the body of the sphenoid bone; becoming fleshy as it passes forwards, it terminates in a tendon, which, piercing the ocular fascia, is inserted into the sclerotic coat—the middle fibres about three, the inferior five, and the superior four lines behind the cornea.

Relations.—It corresponds above to the superior, oblique, and nasal and infratrochleator nerves; below and internally, to the periosteum; and externally, to the branch of the third, which supplies it, the optic nerve, and some fatty tissue.

The optic nerve may be now cut posteriorly, and thrown forwards together with the globe, when the following parts are seen:—Ligament of Zinn, inferior rectus, inferior oblique, and the inferior division of the third nerve.

LIGAMENT of ZINN.—A flat, fibrous band, forming about three-fourths of a circle, attached to the orbital margin of the optic foramen, except at its superior part, and also to the crest separating that bone from the sphenoidal fissure; it is continuous posteriorly, with the dura mater; and anteriorly, gives off three slips—one for the internal, a second for the inferior, and a third for the external rectus.

INFERIOR RECTUS, or DEPRESSOR OCULI.—Placed on the floor of the orbit, arises tendinous from the lower edge of the optic foramen and ligament of Zinn, and soon becoming fleshy, passes forwards, terminating in a flat tendon, which pierces the ocular fascia, and is inserted into the sclerotic coat, about four lines behind the cornea.

Relations.—It corresponds above, to the optic nerve, inferior division of the third, and the globe of the eye; while inferiorly, it is separated from the floor of the orbit, by the inferior oblique muscle.

INFERIOR OBLIQUE, may be dissected either from above, by throwing forward the optic nerve and the globe of the eye, or more conveniently, by separating the conjunctiva attaching the lower lid to the globe of the eye. Triangular in shape, it arises narrow from the orbital edge of the superior maxillary bone, external to the groove for the lachrymal sac; occasionally also, from the inferior orbital process of the malar bone, and passing upwards, backwards, and outwards, beneath the ocular fascia, forms a tendon, which,

piercing the inferior rectus, is inserted into the sclerotic coat posterior to the transverse axis of the globe, behind the tendon, of the superior oblique, and between the external, and superior recti.

Relations.—It lies at first, between the inferior rectus and the floor of the orbit, then between the external rectus and the globe; while the external branch of the inferior division of the third, lies on its ocular surface.

The motions of the eyeball, resolve themselves into movements on the vertical and transverse axis, into those on a variable axis, and into those on the antero-posterior axis. Under the first, occur abduction, adduction, elevation, and depression, all of which are produced by the four recti muscles; under the second, diagonal motions, which, being compounded of any two not directly opposed to each other, may also be produced by the recti—as, for instance, the combined contraction of the superior and external recti will turn the eye upwards and outwards; and under the third, are rotatory motions, purely influenced by the oblique muscles, the superior rotating the eye outwards and downwards, and the inferior downwards and inwards (Johnstone), although from the anatomy and attachment of those muscles, we would be led to infer that the superior oblique would turn the pupil upwards and inwards; while the inferior would direct it downwards and outwards: but these opinions are rendered nugatory by the experiments of Dr. G. Johnstone; the oblique muscles may also press the globe against the inner wall of the orbit; and while altering the optical parallax, likewise advance the eyeball. With reference, however, to the advance and retraction of the globe, it appears that these motions are extremely limited, as the oblique, and recti, exactly antagonize each other.

THE GLOBE OF THE EYE.

The globe of the eye is situated in the anterior part of the orbit, fixed in its position by the optic nerve, and the muscles which surround it, and retained in contact with the lids by the ocular fascia and the conjunctiva, which last covers and adheres to about the anterior third of the eyeball. It is of a spheroidal figure, but to its front is attached a segment of a smaller sphere, which increases the antero-posterior diameter to eleven lines, while the vertical and transverse are only ten; it is divided into three coats, and a similar number of humours, the former being the sclerotic, with the cornea in front, the choroid, and the retina; while the humours are, the aqueous, vitreous, and crystalline. Several other membranes have been also enumerated, such as the hyaloid, aqueous, iris, &c., but these will be more properly discussed with the several parts to which they are connected.

The SCLEROTIC COAT constitutes about four-fifths of the external investment of the globe, and belongs to the class of fibrous tissues; commencing posteriorly at the entrance of the optic nerve, which pierces it, internal to the centre, by a cribriform aperture; it terminates apparently at the margin of the cornea, and it was for a long time customary to describe its corneal aperture as being bevelled on its inner edge, while the cornea, bevelled on its external, was received into it, like a watch-glass into its case; but recent investigations have proved that a perfect fusion of their structure occurs, the cornea only differing from the sclerotic in the altered arrangement of its elements. An antero-posterior section shows the sclerotic to be of different thicknesses in its several parts, being much thicker behind than in front, and thinnest a little anterior to its centre, and this augmentation posteriorly is found to be greater in those classes of animals in which the eye is flattened from before backwards, as for instance, in birds and fishes, where it is reinforced by a thin meniscus of cartilage, in the substance of the fibrous tissue, which is even sometimes bony, as in the sea-bream (Professor Jacob). Again, in the same animals, in the anterior part of the same structure, fourteen or sixteen triangular plates, surrounding the corneal aperture, are found, well marked in birds, but though present in reptiles, they are less regular; not so however, in the ophidia, as they are almost as distinct in that class as in the bird tribe.

Structure of the Sclerotic.—It is composed of white fibrous tissue, with a small amount of the yellow elastic element, the bands crossing each other at right angles, inclosing oval interfibrous spaces, most numerous posteriorly. The vessels which supply this tunic are derived from the palpebral branches of the ophthalmic, together with the ciliary arteries; nerves have not been seen to terminate in it, but the absorbents are very numerous.

Relations.—Externally, it is covered by the ocular fascia, receiving also the insertions of the recti and obliqui, while internally, it corresponds to the ciliary vessels and nerves, which enter it by a series of perforations at its posterior part, and separate it from the choroid coat. When the deep surface is examined, its smoothness is such that Arnold conceived that it was lined by a serous membrane; but if a portion of its dark surface is sliced off and submitted to microscopic examination with a low power, the lax and watery areolar threads are most obvious, as the uniting media with the choroid. The object of this tunic appears to be, for the defence of the more sensitive and delicate structures internally, while it also serves to prevent any rays of light entering the globe, save those admitted by the cornea.

CORNEA, is also a modification of the fibrous element, although by the older anatomists it was believed to be analogous in structure to corneous tissue (nails), or cartilage. It is a circular concavo-convex, or meniscus lens, constituting a segment of a smaller sphere than that of the sclerotic, the anterior deficiency of which it exactly occupies, but appearing to be a little greater in the transverse direction than the vertical, which arises from the fact of its being more overlapped by the sclerotic in the latter situation than in the former. Structurally, it combines five layers, from superficial to deep,—namely, conjunctiva, anterior elastic cornea, cornea proper, posterior elastic cornea, and membrane of the aqueous humour. The conjunctival layer adheres very intimately to the elastic tissue which lies immediately beneath it, and which would appear to constitute its basement membrane, as the only element of the conjunctiva which is truly prolonged over the cornea, is its epithelium. That there is, however, a direct continuity of the sclerotic and corneal conjunctiva is proved by the fact, that in reptiles which cast off the skin annually, the whole conjunctiva desquamates at the same period, the animal being blind for a certain time; and likewise, when the eye is subjected to maceration, the entire layer can be torn off. The disease named pterygium, raises the sclerotic conjunctiva, and when fully formed, impinges likewise on the corneal, elevating its mucous layer also as a distinct structure from the elastic.

The Anterior Elastic Cornea, consists of a transparent lamina of elastic tissue, perfectly homogenous in its nature; it covers the superficial surface of the cornea propria, sending filaments from its deep aspect into its structure, and from its margins into the sclerotic, even as far as the ciliary ligament, its use being to preserve the requisite sphericity of the anterior face of the cornea.

The Cornea Propria, consists of a peculiar modification of the white fibrous tissue expanded into a membranous form, constituting laminæ from sixty to seventy in number, united to each other by filaments of a similar structure, and forming areolæ, which differ from those of the sclerotic in being tubular, and crossing each other at acute angles, but without any communication between them. These tubules have membranous walls perfectly transparent, their cavities being merely damped by moisture, but never in the normal condition containing any appreciable quantity of fluid; nuclei become evident, by the action of acetic acid, as in the fibrous tissues of other situations. It must be also noticed that Müller believes the true cornea to belong to fibro-cartilaginous tissues, while Toynbee, on the other hand, considers it as a cellular cartilage. The margins of the lamellated cornea, are perfectly continuous with those of the sclerotic—in fact, both are inextricably fused with each other.

Posterior Elastic Cornea, situated beneath the last, is thus described by Professor Jacob :—" The structure here alluded to, is a firm, elastic, exquisitely transparent membrane, exactly applied to the inner surface of the cornea proper, and separating it from the aqueous humour. When the eye has been macerated for a week or ten days in water, by which the cornea is rendered completely opaque, this membrane retains its perfect transparency ; it also retains its transparency after long-continued immersion in alcohol, or even boiling water. When detached, it curls up and does not fall flaccid or float loosely in water, as other delicate membranes ; it also presents a peculiar sparkling appearance in water, depending on its greater refractive power ; in fact, it presents all the characters of cartilage, and is evidently of the same nature as the capsule of the crystalline lens "—(Article, Eye, in *Todd's Encyclopædia*, p. 179). When sloughing or ulceration extends so deep as to reach this membrane, a pellucid prominence presses forwards into the opening ; and when an opacity results after puncture, it resembles in appearance capsular cataract ; but its structure is very different from cartilage, being composed of elastic tissue with scarcely a visible character, and not affected by acids, as is the case in the ordinary fibrous tissues ; the use of this layer is, to preserve the requisite concavity of the posterior surface of the cornea. The cornea becomes opaque if the globe is subjected to compression ; and this has been attributed to the expression of the fluid out of its areolar structure, and again to an opposite condition—namely, the expression of a larger amount of fluid from the anterior chamber into its areolæ ; but if a small lamina raised by a needle, is subjected to pressure, it likewise becomes opaque, proving that the opacity depends on a derangement of its intimate structure. The membrane of the aqueous humour, which lines its posterior aspect, is merely epithelial in its character.

Organization of the Cornea.—The vessels of supply consist of two sets—superficial, and deep—the one being conjunctival, which pass in, on the edge of the cornea, for from one-eighth to half-an-inch, then, turning back, they terminate in the veins ; while the other, derived from those of the sclerotic, pass in only to the margin of the cornea, and then are reflected back, to terminate in veins. Thus, while in iritis, the one set form a band of redness around the edge of the cornea ; in corneitis the other permeate the corneal tissue itself (Toynbee *Philosophical Transactions*, 1833). The proper substance of the cornea is destitute of sensibility, and an extensive plexus of absorbents ramifies on its superficial aspect (Arnold).

The cornea transmits and reflects the rays of light, while from its power as a meniscus lens, it also refracts them towards the perpendicular. In the infant, it is more convex than in the adult, and

more so in the latter than in old age; and on this, in a great measure, depends those conditions known as myopia, and presbyopia; in the former, the excessive convexity of the cornea refracts the rays too forcibly, and they, diverging very much as they pass from a near body to the eye, require augmented refraction, and hence persons with too convex corneæ are near-sighted; while in old age, from the cornea becoming flattened, and its margins opaque (arcus senilis), it exercises but slight refractive power, and the rays of light passing almost parallel to each other from distant objects, require but slight convergence; and hence with advancing years far-sightedness usually occurs. In fishes, the cornea is almost flat and is exceedingly thin in the centre, this being compensated by the dense medium which the light traverses, as well as by the sphericity of the lens; while in high-flying birds, the cornea is very convex, owing to the rarity of the surrounding atmosphere; it is totally absent in the cuttle-fish, its place being supplied by the transparent dermoid tissue.

By now making, in a fresh eye, four incisions from the entrance of the optic nerve to the margin of the cornea, and cautiously reflecting forwards the flaps, the choroid coat will be exposed.

Choroid Coat.—Is of a dark, brownish-black colour, and extends from the entrance of the optic nerve posteriorly, to the ciliary body anteriorly; it is united externally, to the sclerotic by fine areolar filaments, through which the ciliary nerves and vessels run to their destination; while internally, it corresponds to the retina. It is divided into three layers—the external, or venous (vasa vorticosa); the middle, or arterial (tunica Ruyschiana); and the internal, or pigmental, or coloured membrane (membrana pigmenti). The venous layer, when well injected, presents a very beautiful appearance, as the vessels run in whorls, from before backwards, and terminate in from five to seven emissory trunks, which, piercing the sclerotic coat, pour their blood into the opthalmic vein. The middle layer, or tunica Ruyschiana, is formed by the ramifications of the short ciliary arteries, which run from behind forwards, and frequently anastomose with each other by cross branches; while the membrana pigmenti consists of a layer of hexagonal plates of epithelium, containing pigment granules, composed of carbon, or the oxide of iron. On tracing the choroid coat forwards, it becomes continuous with the corpus ciliare, which may be considered as being made up of the ciliary processes and ligament, with the superadded ciliary muscle.

Ciliary Processes, may be thus exposed:—After having removed the sclerotic, cut off the posterior half of the choroid, and vitreous body with a scissors, and place the eye resting on the cornea on a white plate, with a little water; the ciliary processes will then be

seen, about sixty in number, alternately long and short, forming a series of plications, or foldings backwards and inwards, of the choroid coat, each ciliary process being triangular, with the base in front turned inwards and forwards, attached to the posterior surface of the iris (iridian border), and the apex directed backwards and outwards, which, with the external surface, is continuous with the choroid ; internally, they impress the surface of the vitreous body on its anterior aspect, constituting the corona ciliaris, or zonule of Zinn ; they likewise surround the margin of the lens, but are separated from it by the canal of Petit, and also form the circumferential boundary of the posterior chamber. The vessels of the choroid, are continued into these processes, where they terminate in loops; but the venous structure certainly does not predominate over the arterial, as supposed by some anatomists.

Ciliary Ligament, or Circle, may be seen by raising the sclerotic, and then cutting away the cornea all round externally; it is of a pinkish-grey colour, a section of it representing a triangular figure, corresponding externally, to the sclerotic, ciliary muscle, and the canal of Fontana, the last being a flattened space existing between the ligament and the sclerotic, probably a venous sinus, as it is capable of being injected ; anteriorly, to the cornea ; posteriorly, to the choroid, and ciliary processes ; and internally, to the iris, which is suspended from it. It is also pierced by the ciliary nerves and long ciliary arteries; but it having been observed that all the nerves which perforated it did not emerge again, either in the same number or of the same size, it was supposed from this fact, as well as from its colour, to be really a nervous ganglion (Soemmerring).

The ciliary muscle may now be examined, and this may be done by raising a portion of the sclerotic coat, as far as the margin of the cornea. It appears as a greyish semi-transparent structure, situated behind the ciliary ligament, and external to the ciliary processes, consisting of a series of unstriped radiating fibres, which arise from the ciliary ligament, and passing backwards are inserted into the ciliary processes, under cover of the sclerotic, as far back as their apices. This muscle, which was described by Porterfield, will advance the ciliary processes and the lens; a structure somewhat similar in character has been described by Sir Philip Crampton, but it exists in birds only, and its fibres are striped.

General Remarks on the Choroid Coat.—As a membrane, it is exceedingly vascular, but does not exhibit the same tinge in all animals, being silvery in the perch, jet-black in the shark ; and in the eyes of herbivora, as well as in the felinæ, presenting at its posterior part a lustrous greenish layer of a fibrous texture, the epithelium on its surface being destitute of pigment granules as in albinos ;

this which is called *tapetum lucidum*, reflects the rays of light a second time on the retina, particularly where they are weak. In osseous fishes a small, reddish, glandular mass is found at the posterior part of the choroid, covered by silvery grey membrane,—the *choroid gland*, the use of which is unknown; and in birds a plicated vascular process passes forwards in the vitreous humour so far as nearly to touch the lens, which is called the *pecten*. The use of the choroid coat is, to preserve the cavity of the globe as a dark chamber, and absorb the superfluous rays of light.

RETINA.—The nervous tunic of the eye may be described as an expansion of the optic nerve, commencing posteriorly at its entrance through the choroid coat, and terminating anteriorly in a dentated margin at the ciliary processes. It is divided into three layers, the most external, or Jacob's membrane being serous; the middle, nervous; and the third, or most internal, vascular. On removing the sclerotic and choroid coats, under water, from a perfectly fresh human eye the external layer is exposed, or the serous tunic, of which Dr. Jacob gives the following description, he being the first anatomist who directed attention to this structure:—"If the exposed surface be now carefully examined, an experienced eye may perceive that this is not the appearance usually presented by the retina; instead of the blue, white, reticulated surface of that membrane, a uniform villous structure, more or less tinged by black pigment, presents itself. If the extremity of the ivory handle of a dissecting-knife be pushed against this surface, a breach is made in it, and a membrane of great delicacy may be separated and turned down in folds over the choroid coat, presenting the most beautiful specimen of a delicate tissue which the human body affords. If a small opening be made in the membrane, and the blunt end of a probe introduced beneath, it may be separated throughout without being turned down, remaining loose over the retina. If a few drops of acid be added to the water after the membrane has been separated, it becomes opaque and much firmer, and may thus be preserved for several days even without being immersed in spirit. The extent and connexions of this, are sufficiently explained by saying, that it covers the retina, from the entrance of the optic nerve to the ciliary processes"—(*Todd's Encyclopædia*, Article, Eye, p. 186). He also remarks, that it is exceedingly delicate in the infant, firmer in the adult, and stained by the pigment of the choroid; it presents the same characters in all classes of mammalia, while in birds it is of a rich yellow colour, and in fishes of a clear white snowy appearance. The structure of this membrane is peculiar, consisting of club-shaped bodies, with the smaller end lying on the retina, and the larger in connexion with the pigmental layer of the choroid coat, those bodies

showing a tendency to separation when immersed in water, and seemingly bent at their larger end. This membrane forms the connecting link between the retina and epithelial layer of the choroid, and corresponds to the bacillous layer of Wagner.

The *Second Nervous Tunic*, consists of three strata, the most internal being a fibrous grey layer, formed by the tubular fibres of the optic nerve, deprived of the white substance of Schwann ; it is fused into a continuous membrane, and is peculiar in being the only element of the retina that passes over the entrance of the optic nerve, this point being insensible to the influence of light, and situated one-eighth of an inch internal to the axis of vision ; the second layer, lying external to the last, consists of ganglionic cells (tunica cellulosa of Wagner), which form a much thicker stratum behind than before ; and still more externally, a thin granular stratum exists in immediate contact with the membrana Jacobi.

Vascular Layer of the RETINA is formed by the arteria centralis retinæ, which enters through the centre of the optic nerve, where it occasions a dark spot on the retina,—*porus opticus*, and then divides into capillaries to form the vascular layer. By making a transverse section of the globe in its posterior part, and exactly in the axis of the vision, the *punctum aureum* of Soemmerring is observed. This point is about $\frac{1}{24}$th of an inch in diameter, and appears as a depression in the retina, surrounded by a yellow margin ; it is the most sensitive part of the whole surface, and exhibits the most distinct image, but although uniformly present in man, still its existence in other animals is extremely limited, being confined to the quadrumana and a few reptiles, as described by Dr. Knox. The retina is the seat of visual impressions, and being pale, bluish, and semitransparent, images painted on it can be seen, when the sclerotic and choroid coats have been removed.

IRIS, is a circular fold of membrane, with an aperture (*the pupil*) not exactly in its centre, but a little nearer to the nasal than to the temporal margin; floating in the aqueous humour, it forms an imperfect septum between the two chambers of the eye, and presents two margins—the external or ciliary, thick, and receiving fibres from the cornea elastica anterior, is attached to the ciliary ligament; the second or papillary edge thin and well defined surrounds the pupil, The anterior surface exhibits a striated aspect, with numerous fibres converging from the external margin to within $\frac{1}{12}$th of an inch of the pupil, where they terminate in a circular set of knotted and thicker elevations, from which again branching filaments pass inwards, to the verge of the aperture ; while the posterior surface, dark and tinged by the pigmentum nigrum *uvea*, or lies for its external third in contact with the ciliary processes, but its internal

two thirds are free in the posterior chamber. Through its structure numerous arched branches of the long ciliary arteries ramify with the ciliary nerves, and so great is its vascularity, that some authorities consider it to be distinctly erectile. The principal fibres composing it run from the ciliary towards the pupillary edge, while near the latter a fasciculus of circular fibres may also be detected, the last being very apparent in birds, and of the striped variety of muscular structure, but in man they are undoubtedly unstriped. Moreover, it has been supposed, by certain authorities, that the radiating fibres are merely elastic, while the circular are truly muscular, and hence belladonna, acting by paralysing the circular set, the elastic, still preserving intact their physical property, dilate the pupil. But although these fibres are evidently unstriped, still, pathologically considered, they are rather to be allied to the voluntary muscles; for in coma, which paralyses only the latter, the pupil is uniformly dilated. Although motor filaments derived from the third can be traced to the iris, still the mechanical stimuli which excite muscular contraction fail to produce that effect in the pupil, as is occasionally evidenced during the operation for cataract; for the iris, if accidentally pierced by the needle, remains perfectly quiescent under the irritation, and it is only by acting on the retina, that contractions can be induced. The iris in fishes is immovable, and of a green colour, and the pupil angular, while in the horse a thin membrane exists, which passes across the pupil like a curtain, giving it an opaline blueness, although when raised, the aperture is dark. The use of the iris is, to regulate the amount of light which impinges on the retina, and to correct the aberration of sphericity, by intercepting the marginal rays.

Membrana Pupillaris, consists in fœtal life of a thin semitransparent membrane thrown across the pupil, into which the vessels of the iris enter, forming loops which closely converge, but do not, however, touch in the centre (Cloquet), but according to Dr. Jacob, a portion always remains up to the ninth month, and traces of its existence can be discovered a fortnight after birth. Wrisberg, Blumenbach, and Cloquet, account for its rupture by the reaction of the loops of the blood-vessels which enter it; but, according to Dr. Jacob, the first step is diminished vascularity, and secondly, absorption; the use of this membrane appears to be to preserve the circular figure of the pupil, during the development of the iris.

Chambers of the Eye, are two in number, an anterior, and a posterior; the former, bounded anteriorly by the cornea, and posteriorly by the iris, is capable of containing about three drops of fluid; while the posterior, which is bounded behind by the lens, anteriorly by the iris, and is surrounded by the ciliary processes, being deeper in

the latter situation than in the centre, will contain about two drops, being, therefore, one-third less than the anterior. Both these chambers are lined by an epithelial layer, beautifully tesselated, and are filled by the aqueous humour, weighing about five grains. While the pupillary membrane remains entire, the iris lies in contact with the posterior aspect of the cornea, and at this period the aqueous humour is confined to the posterior chamber, as a clear, serous fluid holding albumen and salt in solution.

Vitreous Body.—This semifluid mass occupies the posterior four-fifths of the globe, and is bounded posteriorly and laterally by the retina, and anteriorly by the ciliary processes and the lens, the latter being buried in a concavity on its anterior surface. Its capsule, named the *hyaloid* membrane, is a structure of extreme delicacy, surrounding the vitreous fluid at all points, and likewise sending sepimenta or partitions into its cavity, dividing it into cells, which are believed by some to communicate, but the escape of the whole vitreous humour from a single puncture may be accounted for by the fine homogeneous nature of the investing membrane permitting a slow transudation; anteriorly, and surrounding the margin of the lens, the surface is marked by a series of plaiting, produced by the impressions of the ciliary processes, and constituting the *zonula ciliaris* of Zinn, which is dovetailed or intimately united to the similar circle of the choroid coat. At the margin of the lens the hyaloid membrane appears to split, the anterior layer forming the zonule of Zinn, and the posterior attached to the capsule of the lens, producing a canal of a triangular shape, bounded in front and behind by the hyaloid membrane; internally, by the margin of the lens, which forms its base; and externally, by the ciliary processes, where the apex is situated; it is named the canal of Petit, from the author who first directed attention to its anatomy, and its use appears to be, to allow the ciliary muscle to advance the lens, during visual adaptation. The presence of this canal may be shown by injection, when it exhibits a beaded appearance, owing to the ciliary processes impinging on it. In the centre of the vitreous body a canal exists, very apparent in fœtal life (canal of Cloquet), through which a branch of the arteria centralis retinæ (artery of Zinn) passes to reach the posterior part of the capsule of the lens; it becomes, however, obliterated in the adult, although it is always easy of detection in the eye of the horse.

COMPOSITION OF THE VITREOUS HUMOUR.

Water,	98.40
Chloride of sodium with extractive matter,	1.42
Albumen,	18
	100.00

The vitreous humour serves as an extensive surface to support the retina, and keep the lens at focal distance from that tunic, while at the same time the rays of light, emerging from the back part of the lens, are on passing through it, refracted from the perpendicular to the point of incidence, and the several pencils which they form are brought to as many foci in the retina.

CRYSTALLINE LENS, is a double convex achromatic, corrected lens, presenting an unequal curvature on both aspects, being more convex behind than before; it is situated in a concave depression on the vitreous humour, and retained *in situ* by the splitting of the hyaloid membrane, so that when the humours are forced from the globe the lens remains attached to the vitreous body. It is likewise enveloped by a capsule proper to itself, and attached to the free surface of the lens by nucleated cells, which to us always have seemed perfectly transparent and devoid of nuclei. After death, a portion of fluid collects within the capsule near the margins; and this was conceived by Morgagni to exist even during life, but we have constantly failed to detect it in the eyes of animals recently killed, and when present after death, we have always found its existence associated with a softening of the surface of the lens, as if caused by the cadaveric solution of that body. The capsule is colourless, structureless, and without vessels, at least in the adult, and is three or four times thicker anteriorly, than posteriorly. The lens measures, in the adult, from one-third to half an inch in diameter, and in the antero-posterior direction from one-eighth to one-fifth of an inch, while it weighs about four or five grains. The age of the subject influences its figure considerably, for while it is nearly spherical in the fœtus, it becomes gradually flatter with advancing years. If the surface of the lens of an infant, or that of a fish, be closely examined, three dark lines are seen to run from the centre for about two-thirds towards the margin, signifying the division of this body into three primitive portions; and if a lens is boiled, or macerated in a solution of corrosive sublimate, and a needle passed horizontally into its substance, layer after layer may be raised, resembling the laminæ of an onion. As the centre is approached, the structure becomes evidently more dense, and is separated into laminæ with greater difficulty, but it is still resolvable into fibres, commencing at the centre of one surface, and terminating at a similar point on the opposite side; these fibres being flat and denticulated at the margin, so that they mutually indigitate—an arrangement better marked in osseous fishes, than in the human subject.

The LENS is composed of albumen, and is extravascular, neither its growth nor pathological conditions appearing to depend on the presence of vessels, at least of those carrying red blood.

The lens refracts the rays of light towards the perpendicular, to so great an extent that they decussate at its posterior surface, which accounts for the inverted image; but during the passage of the rays of light through an ordinary line of this kind, the danger of chromatic aberration, or, in other words, a decomposition of each ray into its elementary coloured parts, with likewise a coloured margin around the part, is incurred; this is however, obviated, in case of the crystalline lens, by its different density at the surface and in the centre; on which account it is called achromatic. It is also observed that rays of light passing through the margin of a biconvex lens are refracted sooner than those which are transmitted through the centre, which would produce a confused image on the retina, through what has been termed spherical aberration; but this is however, corrected by the iris, which prevents the entrance of the marginal rays of light into the eye. If a sharp instrument is introduced into the centre of the cornea, and passed from before backwards through the globe, the following parts will be pierced in succession:—1. Conjunctiva; 2. Anterior elastic cornea; 3. Cornea propria; 4. Posterior elastic cornea; 5. Membrane of aqueous humour; 6. Anterior chamber; 7. Pupil; 8. Posterior chamber; 9. Membrane of aqueous humour, on the lens capsule; 10. Anterior layer of the lens capsule; 11. Lens itself; 12. Posterior layer of lens capsule; 13. Hyaloid membrane; 14. Cells of vitreous body; 15. Hyaloid membrane, at the posterior part of the globe; 16. Vascular layer of the retina; 17. Nervous; 18. Serous; 19. Pigmental layer of the choroid coat; 20. Arterial; 21. Venous; 22. Sclerotic; 23. Ocular fascia; and then the needle will pass into the fat at the back of the globe.

THE EAR.

This organ, devoted to the sense of hearing, occupies in the human subject the lateral region of the skull, lying between the temporo-maxillary articulation in front, and the mastoid process of the temporal bone behind. Its gradual development from its simplest form in the lower class of animals, until it attains its beautifully finished and elaborate condition in the higher, constitutes a continued source of interest to the comparative anatomist, as he traces its first rudimentary appearance in the one, to its ultimate state of exquisite completeness in the other.

Taken as a whole, the ear has been divided into three great parts—an external, consisting of the pinna or auricle, with the external auditory meatus; a middle or tympanum, containing the small ossicula, and having in connection with it, the Eustachian tube; and an internal or labyrinth, composed of the vestibule, cochlea, and semi-

circular canals—the two last, that is to say, the tympanum, and labyrinth, being buried in the substance of the temporal bone, for the purpose of protecting them from that injury to which they would otherwise be so liable, from their peculiarly delicate organization.

Pinna or Auricle, is that portion of the organ of hearing that lies external to the skull; in its outline it is rather oval, but at the same time subject to very great variety in size, position, and general appearance, according to the character of the individual in whom it may be examined. Superiorly and posteriorly it is free, but anteriorly and inferiorly it is most intimately connected to the subjacent bone, by processes of fibrous tissue, which some anatomists have described as distinct ligamentous structures, each with definite attachments; but in this view we cannot coincide, as a careful dissection will show that the fibrous tissue forms one uninterrupted mass, with here and there occasional thickenings, but the latter are never so uniform in their position, or precise in their character, as to entitle them to the designation of ligaments. The bond of union is however, most close and unyielding, and capable of withstanding an amount of violence scarcely to be calculated upon, when the apparently fragile nature of the parts is taken into consideration.

The auricle is composed of cartilage, with the exception of the lobule, which occupies its most inferior part, and which consists of fat and fine areolar tissue, that may be always very easily detached from the cartilaginous portion, by maceration. The superficial surface of the pinna is marked by various irregularities, always constant in the human subject, but at the same time occasionally more intensified in some individuals than in others; these have been called the helix, antihelix, tragus, antitragus, and concha, each of which we will now proceed to describe separately, but briefly.

Helix, is that remarkable fold that borders the ear posteriorly and superiorly, commencing below, at the lobule in common with the antihelix; it passes at first almost directly upwards, then curves forwards, and ultimately bends downwards and backwards, to terminate in the cavity of the concha, which it divides into two unequal parts, the inferior being much the larger of the two.

Antihelix, forms a concentric fold within the last described, with which it arises in common inferiorly, but in its course upwards is separated from it, by a groove called the fossa innominata; it terminates in the superior part of the concha, by dividing into two processes, the inferior being more sharp and prominent than the superior, and inclosing between them a triangular depression, known as the navicular or scaphoid fossa. The origin of the antihelix is in close proximity with the antitragus, but is however, always separated from it by a slight fissure or depression.

Tragus, semilunar in shape, lying external and anterior to the external auditory meatus, and having its internal surface, especially in old age, covered with long thick hairs, and hence its name; when depressed with the finger, it covers, like the lid of a box, the auricular opening.

Antitragus.—Smaller than the last, to which it lies on a plane posterior and inferior, and is separated from it by a deep well-marked depression, called the notch of the concha.

Concha, occupies the inferior portion of the auricle, forming a species of funnel for the collection of sound, which is afterwards transmitted into the external auditory meatus, which is situated in its lower and most anterior part.

Both the exterior and interior muscles of the auricle, have already been described with those of the head and face, and to avoid unnecessary repetition are omitted here. Judging however, from their general character and appearance, their power to exercise any decided influence on the shape or functional uses of the parts to which they are attached, may reasonably be doubted.

External Auditory Meatus.—This tube is a little more than one inch in length, and extends from the base of the tragus externally, to the membrana tympani internally; its direction is not perfectly horizontal, but directed at first slightly upwards and forwards, and then downwards, forwards, and inwards; while it is also partially constricted in its middle. Its external half, composed of cartilage, is constituted by the bending inwards of the tragus and concha, which are united inferiorly; while superiorly, an interval exists between them, which is filled up by dense fibrous tissue; other fissures (incisuræ Santorini), may be also observed, taking a transverse direction, but they are variable in number, as well as in extent; the internal half of the tube is osseous, but had no existence in fœtal life, as it was at that period a mere bony ring, over which the membrana tympani was tensely stretched, a groove being always apparent in the adult bone, indicating the extent of development of the osseous portion, which, from being always longer on its inferior than superior wall, gives a marked obliquity to the membrana tympani when *in situ*. The canal thus formed is lined internally by an involution of the integument, remarkable for its tenuity and vascularity, and its orifice is protected by numerous strong hairs, springing principally from the roots of the tragus and anti-tragus; while in the subcutaneous tissue, but confined to the cartilaginous portion only, are several ceruminous glands for the production of a peculiar secretion, consisting of fat, albumen, colouring matter, and a substance nearly analogous to bile, which is always poured out very freely on the tegumentary surface; the use of this secretion, as well

as that of the hairs, is to entangle and arrest any foreign body that might enter the canal, and thus act injuriously on the delicate organ of hearing. Some anatomists have asserted, that muscular fibres can be detected in the tube, and that they have the power by their contraction of producing a certain amount of shortening of it—but this fact requires confirmation.

Middle Ear, or Tympanum.—In order to examine this cavity properly, the student should have several temporal bones prepared by immersion in dilute muriatic acid, which will render them sufficiently soft to be divided with a strong knife. By removing in one of these the lower part of the tympanum, where it corresponds to the Glaserian fissure, a good view will be obtained both of the shape of the cavity, and of the several parts contained within it.

The middle ear has been compared, not inaptly, to a common drum, or perhaps more truly, to a tambourine, covered in on both extremities, and presenting for examination an external and internal wall, and a circumference. The external wall, constituted by the *membrana tympani*, which separates it from the auditory canal, is nearly circular in shape, and is firmly implanted by its margin into a fissure or groove, which marks out the position of the tympanic ring in the fœtus, but is suspended so very obliquely as to form an angle of about 45° with the lower wall of the external auditory meatus, thus causing one surface to look downwards, forwards, and outwards, and the other upwards, backwards, and inwards. The membrane consists of three layers—an external, or cuticular, which is extremely fine, and continuous with the lining of the tube: an internal mucous, prolonged over it from the cavity of the tympanum; and a middle fibrous, thin, but exceedingly strong, the filaments which compose it appearing to radiate from the centre to the circumference, and which were described by Sir Everard Home as muscular. Taken as a whole, it possesses great strength and vascularity, but is more or less translucent, and is constantly retained in a state of tensity by the tensor tympani muscle, which acting upon the malleus, the handle of which is attached to its centre, renders it convex on its inner surface, and concave on its outer, except superiorly, where a slight convexity is visible, owing to the pressure of the short process of the malleus against it.

Internal Wall, must be examined by removing the membrana tympani, when the following parts will be seen on it:—Most superiorly, the fenestra ovalis; in the middle, the promontory, with the process of bone stretching backwards from it to the pyramid, called the lingua, or tongue; and still lower and slightly posterior, the fenestra rotunda.

The fenestra ovalis is semi-elliptical in shape, concave above, nearly

straight below, directed forwards, and slightly downwards, and situated in a recess of variable depth, known as the fossette; it would form a direct communication between the tympanum and vestibule, but for a membrane (lesser membrana tympani) which is stretched across it in its natural condition, and against which the base or foot of the stapes rests.

The Promontory, which lies immediately below the hole last described, is an elevated process of bone, corresponding, or indeed, formed, by the first turn of the cochlea, and is marked by several small furrows or grooves for the tympanic plexus of Jacobson, the destination of which has been fully considered in the section devoted to the NERVES.

The fenestra rotunda, which lies posterior and inferior to the promontory, is also situated in a depression or fossette, and like the fenestra ovalis, is also closed by a thin membrane (lesser membrana tympani), which separates the tympanum from the tympanic scala of the cochlea, or, to speak more correctly, the former would open into the latter, and also into the vestibular cavity, as the foramen is divided into two by the spiral lamina of the cochlea, which extends downwards as far as this point, but for this membrane.

The circumference of the tympanum may be examined superiorly, inferiorly, anteriorly, and posteriorly. Superiorly, it presents a sulcus or recess, corresponding to a projection on the upper surface of the petrous portion of the temporal bone, and in it is placed the head of the malleus; inferiorly, it is contracted to a narrow groove or furrow, and communicates indirectly with the Glaserian fissure; anteriorly, it is perforated by two canals—a superior, and inferior, divided from each other by a thin plate of bone (processus cochleariformis), the convex surface of which is turned downwards, forming the upper wall of the osseous portion of the Eustachian tube, and the concave upwards, constituting the floor of a more constricted canal, which lodges the tensor tympani muscle; posteriorly, it is marked by one or two irregular foramina, communicating with the mastoid cells, on the internal side of which is the pyramid, a conical projection, of variable size, in the apex of which a hole appears, from which emerges a small cord-like process, apparently composed of fibrous tissue, but which has hitherto been recognized as muscular, under the name of the stapedius muscle.

The tympanum, with the boundaries just described, may be considered, strictly speaking, as merely the posterior dilatation of the Eustachian tube. It is lined by a thin mucous membrane, prolonged from the tube into its cavity, which of course connects it with that of the pharynx, and which is continued, not only over its walls, but is likewise inflected around its ossicula, which form a complete chain

across it, from without inwards. These ossicula, consisting of the malleus, incus, os orbiculare, and stapes, we will now proceed to describe in succession.

MALLEUS.—The most anterior and external of the ossicula, is as its name implies, mallet-shaped, and for description may be divided into a head, neck, handle, short and long process. The head, of an ovoid shape, lying on a plane above the membrana tympani, is almost completely buried in the sulcus or recess described as existing in the upper part of the circumference of the tympanic cavity, being, however, slightly concave below and behind, to articulate with the body of the incus; below the head is the neck, which is constricted and slightly flattened, from which the handle springs at an obtuse angle, passing nearly vertically downwards at first, but afterwards curving slightly outwards, to terminate in a rounded point, which is firmly attached to the centre of the fibrous layer of the membrana tympani; its short process springs from the neck, and bending outwards, rests against the upper margin of the tympanic membrane causing it to project slightly externally, while the long (processus gracilis of Raw) arises from the same part as the last, and proceeding downwards, terminates in a sharp point in the Glaserian fissure, where it affords attachment to the laxator tympani, the muscular structure of which has been latterly, and perhaps with much justice, disputed.

INCUS, has been compared in shape to an anvil or bicuspid tooth, and presents for examination, a body, and two processes,—a short and a long. The body, is irregularly quadrilateral, and presents above and behind, a facette for articulating with the head of the malleus, and like it is situated above, in the recess of the tympanum; its short process thick, strong, and conical in figure, occupies the same situation, and stretches horizontally backwards, as far as the mastoid cells; while its long, much more slender than the other, dips downwards almost vertically, parallel, but internal to the handle of the malleus; and at its termination, bends almost directly inwards, forming a small cup-like cavity, for articulating with the orbicular bone.

ORBICULAR BONE, as its name implies, almost completely spherical, and not larger than a small grain of shot, appears to be simply interposed as a connecting link between the incus and the stapes.

STAPES.—Stirrup-shaped, lying almost horizontally across the tympanic cavity, and inferior to those already described, presents for examination a head, neck, two crura, and a base or foot-piece. The head, directed outwards, is cup-shaped to receive the orbicular bone, and is supported by a contracted neck, from which the crura spring; the crura diverge as they pass inwards, and terminate in the base or

foot-piece, which is elliptical in figure, and rests in the fenestra ovalis, which it accurately fills up, and against the membrane of which it presses; the anterior crus is the shorter, thicker, and stronger, while the posterior is more slender, more curved, and longer, the opposed margins of each presenting a slight groove for the reception of a thin membrane which is stretched between them.

The chain of connexion thus established by the ossicula between the membrane of the tympanum and that which closes the fenestra ovalis is acted upon by three muscles, which are called the tensor and laxator tympani, and the stapedius.

Tensor Tympani.—A narrow, elongated, fasciculus of muscular fibres, attached to the walls of the osseous canal above the Eustachian tube, extending as far forwards as the spine of the sphenoid, terminates in a small flattened tendon, which is inflected outwards, nearly at a right angle, and is inserted into the upper part of the handle of the malleus, below the processus gracilis.

Use.—To draw the handle of the malleus inwards, and thus make tense the membrana tympani.

Laxator Tympani.—Always indistinct, so much so that its muscularity has been doubted, arises from the spinous process of the sphenoid, and winding upwards and outwards to the Glaserian fissure, is attached to the point of the processus gracilis.

Use.—To draw the long process of the malleus downwards and outwards, and thus, by antagonizing the tensor, to relax the membrana tympani.

Stapedius.—Small, and of an oval shape, arises from within the pyramid, and emerging from its apex, passes forwards and slightly outwards, to be inserted into the neck of the stapes.

Use.—To draw the stapes inwards, and press its base against the membrane of the fenestra ovalis.

From the firm connexion of these several small bones to each other, it necessarily follows, that motion produced in any one of them will be propagated in succession to the entire, and hence the effect produced by the contraction of the tensor tympani may be more clearly understood. In rendering the tympanic membrane tense, the muscle draws the malleus inwards, which causes its head to press firmly against the body of the incus, which in its turn is prevented from passing backwards by its short process, which is fixed in the recess of the tympanum. The motion is accordingly propagated to its long process, which again presses against the orbicular bone, and this naturally impels the stapes, with which it is united, against the membrane of the fenestra ovalis. During these movements it will be observed that the processus gracilis of the malleus is the crank or fulcrum on which the motion takes

place, and the better to adapt it to this office, it is firmly attached to the Glaserian fissure by a strong ligamentous connexion, the laxator tympani of some authors. This is the explanation advanced by Huguier, and it appears to be the true one, as the one action renders both membranes, that of the tympanum, and fenestra ovalis, tense at the same moment, and the vibrations which take place in the former, from external causes, are thus rapidly conveyed to the latter, by the osseous chain, and by it as accurately repeated for the labyrinth to take cognizance of them.

The Vidian nerve, which enters the tympanum through a small hole at the base of the pyramid, crosses the cavity from within downwards and outwards, between the long process of the incus and handle of the malleus, and it may be presumed, that it couducts the small twig of the portio dura which Soemmerring describes as passing to the stapedius muscle for its supply.

The Labyrinth, or Internal Ear, consists of three distinct parts —the vestibule, cochlea, and semicircular canals. The attempt to isolate these several parts is a tedious and troublesome operation, and can only be accomplished by repeated practice, and the sacrifice of several temporal bones. The interior of the vestibule may be exposed by removing its upper walls, opposite the fenestra ovalis; the cochlea may be isolated by taking the internal auditory meatus as the guide, and cautiously removiug layer by layer of the upper surface of the petrous portion of the temporal bone, in a directiou downwards, forwards, and outwards; while the semicircular canals can be brought iuto view by removiug carefully, bit by bit, the spongy tissues in which they are imbedded.

Vestibule.—This cavity, bounded exterually, by the fenestra ovalis and tympanum; internally, by the macula cribrosa of the internal auditory meatus; anteriorly, by the cochlea; and posteriorly, by the semicircular canals, is in shape ovoid, but with a ridge or crest encircling it about its middle, and dividing it into two compartments, the superior of which has been called the fovea semi-elliptica, and the inferior, the fovea hemispherica. These two chambers are exceedingly small, as the entire vestibule, both in its vertical and antero-posterior measurements, is not quite a quarter of an inch in length, while transversely it is much less, as it is sensibly flattened in this direction. The foramina which open into it have been divided into the large and small, the former being seven in number, consisting of the five openings of the semicircular canals, which are visible on its posterior wall, the fenestra ovalis, which would establish a free communication with the tympanum externally, only that it is closed by its own proper membrane and the foot of the stapes, and in front the orifice of the scala vestibuli; an eighth may be also ob-

served on its external wall in a macerated bone, which is constituted by the upper part of the fenestra rotunda. The small apertures are those of the macula cribrosa internally, for the passage of the auditory nerve; and the aqueduct of the vestibule, which perforates it posteriorly, for the transmission of the small blood-vessels.

Semicircular Canals, three in number, forming segments of circles of different lengths, the calibre of the tubes being not quite one-sixteenth of an inch in diameter, and being slightly compressed from side to side, have received their names from their positions, and are accordingly called the superior and inferior vertical, and horizontal. The first of these, or the superior vertical, forms a segment amounting to about two-thirds of a circle, with its convexity directed upwards, its position being marked out by a prominence always to be observed on the upper surface of the petrous portion of the temporal bone; its external extremity, which is dilated into an ampulla, opens on the upper and outer part of the vestibule; while its internal, which unites with the corresponding one of the inferior vertical, may be seen on its upper and inner wall, but without any enlargement. The inferior vertical, which describes nearly a complete circle, commences on the inner side of the vestibule, in connexion with the last, at first arches backwards and slightly downwards, and then, bending forwards and upwards, becomes dilated into an ampulla, and opens on the back part of the vestibular cavity at a very short distance from where it had first commenced; while the middle or horizontal, arises on the inner wall of the vestibule, close to the common aperture of the two vertical, and proceeding outwards, and forming only a small segment of a circle, opens on its outer wall by a dilated extremity, between that of the superior vertical, and fenestra ovalis. A very fair idea of the position and arrangement of those curved tubes may be obtained by examining the auditory apparatus in the larger class of birds, as from the soft spongy character of the osseous tissue, the dissection may be made with comparatively little difficulty.

Cochlea, lies anterior to the vestibule, and commences at the internal auditory meatus, and takes a direction forwards and outwards, superior and internal to the carotid canal; a slight ridge on the upper and anterior part of the petrous portion of the temporal bone, behind the depression of the Casserian ganglion, always indicating the position which it occupies. It has been compared in shape to a common snail-shell, and consists of a central axis, called the modiolus or columella, and a hollow canal or tube, divided into two by a thin lamina, partly osseous and partly membranous, winding around it for two turns and a-half, but in such a manner that each inferior coil overlaps that which is immediately above it, an arrangement

which has necessarily a tendency to render the cochlea of a conical figure. In order that a more intelligible view may be obtained of this complicated structure, we will describe each of its component parts individually.

Modiolus or *Axis*, is of an irregular conical figure, with its base turned internally, and appearing in the bottom of the internal auditory meatus, and its apex directed outwards, and slightly downwards and forwards, terminating in a dilated process (scyphus), which inferiorly resembles a cup, but is deficient superiorly, where it presents a smooth margin for its entire extent. The base exhibits numerous foramina for the entrance of the branches of the auditory nerve, which, piercing the bone, run in numerous canals through its structure, throwing off several fine filaments to the external surface for the supply of the scalæ, while its continued trunk, reduced to a mere thread, emerges from the bony tubules in which it was contained, through the centre of the funnel-shaped depression at its apex. The surface of the mediolus is also deeply grooved in a spiral manner, where it corresponds to the attachment of the spiral lamina.

Tube of the Cochlea, or *Lamina Gyrorum.*—About one inch and a quarter in length, if measured on its external or convex wall, but much shorter on its internal or concave; neither is it of the same calibre throughout, for while at its internal part it is about one-tenth of an inch in diameter, at its external it is scarcely one-sixteenth. Its first coil encircles the expanded base of the modiolus, overlapping and becoming fused with that immediately above it, and thus it continues to ascend, forming two turns and a-half, but gradually decreasing in size till it reaches its apex.

Lamina Spiralis, traversing the tube of the cochlea, from one extremity to the other, and dividing it into two secondary tubes, is a thin plate, partly osseous and partly cartilaginous; it commences at the fenestra rotunda, and winds around the modiolus, following exactly the coils of the spiral tube itself, when, having arrived at the funnel shaped apex of the modiolus, it ceases to be attached to it for a short distance, but ultimately becomes connected to it again near its termination. Hence the lamina spiralis divides the cochlear tube into two distinct canals, a superior and external, the scala vestibuli, which communicates directly with the vestibule, and an inferior and internal, the scala tympani, which would open into the tympanum through the fenestra rorunda, but for the membrane, which in the natural condition of the parts completely occludes it. Near the apex of the cochlea, the two scalæ communicate, through an opening which we have already described as existing where the spiral lamina ceases to be attached to the modiolus, this aperture having been described by Breschet, under the name of

the *helicotrema.* It will be now necessary to take a brief view of the structure of the lamina spiralis, and in order to understand it properly, we must suppose it to be completely folded out, in which state it would be of an oblong figure, divided by a line drawn diagonally from the opposite angles, into two triangles—the internal, with its base turned inwards, consisting of a thick plate of bone, perforated by several canals for the cochlear nerves, and terminating by its apex in a curved process (hamulus); and the external, which is membranous, with its base turned outwards, and its apex inwards, corresponding to the base of the internal triangle. It will therefore, naturally follow, when this plate, composed of those different tissues, is coiled edgeways around the modiolus, that the osseous structure must prevail in the first turn, must diminish in the second, and cease altogether in the commencement of the third; but the rule must be reversed in the membraneous portion, as it forms but a very small portion indeed of the first coil, an increasing proportion of the second, and the entire of the third or last half turn.

In addition to the openings of the two scalæ, it will be necessary to mention another, called the aqueduct of the cochlea, which also communicates with the vestibule. This canal, one extremity of which opens into the tympanic scala, and the other on the inner surface of the petrous portion of the temporal bone, near the jugular fossa, can only be considered, like that of the vestibule, as a channel for the removal of the venous blood from the interior of the cavity.

Having now concluded the description of the osseous, our attention must now be directed to what has been termed the membranous labyrinth, and before doing so, it may be necessary to observe, that the latter is by no means as extensive as the former, from being deficient altogether in the cochlea. The membranous labyrinth, consists, in fact, of three semicircular canals, moulded as it were, within, and exactly resembling the osseous; but as the former are much smaller than the latter, an interval exists between them which is filled up by a transparent fluid—the liquor Cotunnii, or perilymph of Breschet; they have likewise the dilatation or ampulla at one of their extremities, and the two vertical open by a common orifice, thus forming for the three five apertures altogether.

The Membranous Vestibule differs from the osseous in consisting not of a single, but of a double cavity, of which one, termed the saccule, situated superiorly, is apparently constituted by the five orifices of the membranous semicircular canals, which expand as they open into it; and the other, the utricle, which lies in the lower part of the fovea semi-elliptica, and which is much larger than the saccule. It has not been exactly determined whether these cavities com-

municate, but the general idea is, that they do not. Like the membranous semicircular canals, they are likewise surrounded by the perilymph of Breschet, and they are all preserved in a distended state by a similar fluid, called the endolymph of Scarpa. It should be recollected that, although the cochlea is devoid of apparatus similar to those just described, still it, as well as the vestibule and semicircular canals, is lined by a fine fibrous membrane analogous to serous, which adheres closely to their bony walls, constituting in fact, a periosteum for the entire cavity.

Within the membranous utricle and saccule, there exists a cretaceous powder, deposited in two white shining masses, analogous to the calcareous deposits found in the ears of fishes, and known by the name of otolithes, but which, in the human subject, from their liability to fall into powder, have been called otoconia. They are supposed to be of use, in increasing and condensing the perception of sound within the labyrinth.

In the description of the tympanum, we have already remarked, that the vibration produced by sound on its membrane is propagated by the chain of bones directly to the membrane of the fenestra ovalis, and so to the fluid which fills the vestibular cavity; but in addition to this, it also reaches that cavity through the fenestra rotunda, and so through the scalæ, but in a less intense form. The bones of the head also form a conducting medium, but it would appear that sonorous undulations thus conveyed, act only through the cochlea, and of course their perception is not so distinct as in the preceding instances.

The ear derives its supply of blood from the external and internal carotids, the basilar and cerebellar; its nerves, are borrowed from the sympathetic, seventh, and eighth; these will be found fully described in the sections devoted to each system.

The organ of hearing is found to exist in the great majority of the animal series, but its development is by no means equally well marked in all. In the gasteropoda and crustacea, it consists of a simple sac filled with fluid (containing certain siliceous particles, otolithes), to the walls of which the nerve is distributed; in the fish tribe the organ becomes more complex, possessing a vestibular sac divided into two—the utricle and sacculus, with generally three semicircular canals opening into the former, while the watery fluid which incloses them is supposed to be derived from the cerebro-spinal; the otolithes in this class are large and of various figures, but it is to be observed, that in several of the osseous variety there appears to be no orifice of communication externally, and the whole of the auditory apparatus is contained in a cavity of the cranial wall. In the amphibia, the organ of hearing has become circumscribed from the adjacent bones,

and is constituted by a vestibule, three semicircular canals, and occasionally a tympanum closed by a membrane, from which an osseous pillar (columella), or two or three small bones, analogous to the human ossicula, stretch to the wall of the vestibule. In the reptiles, a rudiment of the cochlea appears, with a Eustachian tube, but crystalline deposit takes the place of the otolithes. In birds, the auditory apparatus is very complete; it consists of all the parts which are found in the higher order of the reptiles, with some few additions; while in the whole class of mammalia the organ is closely analogous to that of man. (For a more detailed account of the gradual development of the ear, the student may consult Todd and Bowman's *Physiology*, and Roget's *Bridgewater Treatise.*)

SECTION VI.

ARTERIES AND VEINS.

The vessels of the body are divided into the arteries, veins, and lymphatics; the first, or the *arteries*, being elastic, yielding, membranous tubes, that commence by the great systemic vessel—the aorta, which, breaking up into branches, ultimately terminates in the capillaries that constitute the connecting link between those vessels and the veins. The arteries are usually found empty after death, but present sufficient resistance, even in that condition, to maintain their cylindrical form. Commencing by trunks, they divide dichotomously as a general rule, and the combined area of the branches (with the one exception only, that of the basilar) exceeds that of the trunks from which they emanate, and the arterial system would, therefore, represent a cone, with its apex situated at the root of the aorta, and its base at the capillaries. The arteries, generally speaking, are described as having three coats—an external or areolo-fibrous, a middle or elastic, and an internal or serous; but these are further subdivided into additional layers, of which six have been enumerated, and which we will now proceed to describe in succession :—

Areolo-fibrous Coat, consists of an investing tubule of condensed or membraniform areolar tissue, moulded by its deep surface, which is remarkably dense, on the middle coat, while externally it is more lax, and connects the vessel to the surrounding parts. The fibres which constitute it are either spiral, longitudinal, or interlacing in their direction; and although composed merely of the elements of

ordinary areolar tissue, still the elastic fibres almost invariably predominate—in fact, become continuous with the middle coat. This tunic is the most resisting constituent of an artery; and it is observed that, after the internal and middle have given way, as in aneurism, that it supports the impulse of the circulation for a long period, and likewise, after the application of a ligature, that while the internal and middle coats are divided, the external remains entire; this tunic is thin in the aorta, as well as in the arteries of the brain.

The Middle Coat, may be divided into a circular and longitudinal set of fibres, with a muscular stratum. The circular fibres are composed of yellow elastic tissue, constituting nine-tenths of the whole thickness of the arterial coats; they are penniform in their character, and intermixed with nonstriped muscular fibres, while internally they observe a similar arrangement; but the fibres pursue a longitudinal direction, and are extremely coarse. The muscular fibres, which do not form any distinct stratum, but are interwoven with the penniform elastic filaments, present large oval nuclei at intervals, and are principally found in the middle-sized, and smaller vessels.

The Internal Coat, consists of an internal tesselated layer, the scales being elongated or oval, and provided with very large nuclei, which disappear with great rapidity after the death of the animal, and a recent specimen should therefore be selected for their demonstration; this layer is supported by a stratum of flat, glistening, elastic bands, exhibiting numerous depressions in their intervals, and has been described by Henle as the fenestrated layer. Hence, the six coats of an artery may be thus enumerated from without inwards—1. Areolo-fibrous; 2. Circular-muscular; 3. Elastic; 4. Longitudinal-muscular; 5. Fenestrated; and 6. Serous.

The *capillaries*, the connecting channels between the arteries and veins, permeate the tissues of organs, performing the function of nutrition, and initiating those changes concerned in the production of animal heat; their average diameter is about $\frac{1}{3000}$th of an inch, and they ramify rather in the proximate than the ultimate structure of organs. Those vessels can easily be examined in the substance of the pia mater, where their coat appears of an homogeneous nature, but interrupted at intervals by nuclei; in the larger branches, cross markings are seen, indicating the presence of circular fibres, which resemble in character the nonstriped muscular, but differ however, from them, in not containing nuclei; and when the passage of the blood through these vessels is examined in the web of the frog's foot, the current is observed to be continuous and uninterrupted by the ordinary arterial rhythm.

The *veins* commence by radicles in the substance of parts and organs, and gradually coalescing, form trunks by which the venous

blood is poured into the heart; their coats are much thinner than those of the arteries, and when empty they collapse, although after death their cavities are usually found distended with blood. The elements of the venous tunics are similar to the arterial, but not developed to a like degree; thus externally, a thin areolo-fibrous tunic corresponds to the same coat of the arteries, internal to which is a fibrous layer, consisting of an external circular set of fibres, extremely weak, supported on a longitudinal fibrous tunic, and between these, unstriped muscular filaments are situated; while again, more internally, there is a fenestrated layer supporting the epithelium on its deep surface. The veins are provided with valves, more numerous in the deep set, but totally deficient in those of the neck, sinuses, abdominal veins, vena azygos, and iliacs, as well as in the cavæ; but the external jugular forms an exception to the absence of valves in the cervical veins, as it possesses two, but both very faintly marked. In the larger vessels, three valves are opposed to each other, while in the smaller, there are two only; and again in the smallest they are absent altogether. A venous valve is formed by a replication of the serous lining, containing between its layers a process of the fibrous venous wall, each valve presenting a convex edge, which is attached to the inner surface of the vein, and a concave margin, free, looking towards the heart, while the vessel immediately above it exhibits a slight dilatation. These valves prevent the occurrence of regurgitation during muscular pressure on the vessels, as the blood is gradually urged towards the heart.

AORTA.

The great origin of the entire arterial system, commences in the cavity of the thorax from the superior, anterior, and right side of the left ventricle, by a large trunk called the aorta, which at first ascends upwards, on the right side of the sternum for some distance, then bends backwards and towards the left side, till it reaches the spine, and again descending along the left side of the spine, through the posterior mediastinum, enters the abdomen between the crura of the diaphragm, to terminate ultimately about the fourth lumbar vertebra, by dividing into the common iliacs. In order to facilitate its description, and to render its complicated relations more intelligible, it has been generally divided into three parts, viz.—the arch, the thoracic, and abdominal portions. But before entering into a detailed examination of these several divisions, it will be necessary to state briefly its mode of attachment to the heart, and its peculiar relations at its point of connexion to this organ, with the peculiar mechanism which nature has employed (valves) to obviate that re-

gurgitation which must have naturally resulted from the elasticity of this capacious tube, had no means been providentially employed in order to prevent it.

In the description of the left ventricle of the heart, it has been shown that at the right extremity of its base a fibrous annulus is situated and connected to its muscular structure, to which the name *aortic zone* has been applied. This zone presents to the touch a sensation of a dense, resisting ring, and to this the vessel under consideration is attached in the following manner :—From the distal edge of the zone three triangular processes are given off, their bases broad and continuous with each other at the zone, but as they ascend towards the artery they leave between their apices certain spaces of a conical form, into which are fitted three festooned processes or prolongations from the middle coat of the vessel, forming, in fact, a mutual indigitation with each other, over which is prolonged, the serous membrane of the pericardium externally, and the endocardium or ventricular lining internally. The edges of the roots present crescentic margins internally, the concavities of which look towards the vessel, and to their sharp edges are attached the convex margins of the three semilunar valves which circumscribe a similar number of interspaces or pouches, originally described by Morgagni, afterwards by Valsalva, and now generally known as the *aortic sinuses.* Those valves are precisely the same in structure as the tricuspid or mitral already described, consisting of a thin process of fibrous tissue prolonged from the roots to which they are connected, and covered on both surfaces by a layer of serous membrane from the lining of the artery; their figure is such as their name would imply, but remarkable from the fact of presenting in their free margin, about the middle, a small but firm tubercle, of variable size, and always constantly present, called the corpus Arantii. The fibrous structure constituting these curtains, although exceeding thin, still presents an arrangement of its fibres easily demonstrable, the most external forming continuous curves parallel to their attached margins, while the internal, on the contrary, which are much thicker and stronger, form a double crescent, of which the cornu of the valve constitutes one extremity, and the tubercle or corpus Arantii the other. Now, in the passage of the blood from the ventricle into the aorta, those valves are necessarily thrown up against its walls, and here the corpora Arantii accomplish a very important office, in producing such an amount of separation between them, as to permit the fluid to insinuate itself between the curtain and wall, and by distending the aortic sinuses, to act mechanically on the valves by forcing them downwards, and thus opposing the retrogade course of

the compressed stream; the Arantian bodies have been likewise said to strengthen the valves, and to occlude more accurately any minute aperture that might possibly exist between their approximated margins.

If we now direct our attention to the boundaries of the commencement of this vessel, or the aortic zone, we will find them to be the following:—Anteriorly, the prolongation upwards of the base of the right ventricle or infundibulum, coronary arteries, and superficial cardiac plexus; posteriorly it rests upon, and is accurately adapted to the anterior median furrow between the two auricles; on the right side, it corresponds to a groove between the infundibulum and auriculo-ventricular orifice, and on the left to the wall of the corresponding auricle. It is from this strong dense and unyielding zone, that the arterial system may be said to commence, sending from this point its varied and intricate network through the entire body, until the remotest part has received its proper proportion of a fluid so essential to its nutrition.

Arch of Aorta, commences at a point corresponding to the junction of the cartilage of the fourth rib with the sternum, on the left side, from which it passes upwards, forwards, and to the right as far as the second costal cartilage (*ascending portion*); from this point it turns backwards and slightly upwards, crossing the upper part of the thorax, in an oblique direction, to the left side of the second dorsal vertebra (*transverse portion*), and then descending vertically, terminates at the inferior margin of the third, (*dorsal vertebra*), by becoming continuous with the thoracic aorta.

Relations of Ascending Portion.—Anteriorly, sternum, pericardium, with its serous lining, infundibulum, coronary and pulmonary arteries, and superficial cardiac plexus; posteriorly, left auricle, right pulmonary veins, and artery, and posterior cardiac plexus; to the right side, the right auricle and vena cava descendens; and to the left, the appendix of left auricle, and bifurcation of pulmonary artery.

Relations of Transverse Portion.—Anteriorly, sternum, origin of sterno-thyroid, remains of thymus gland, left vena innominata, which is also superior to it, left phrenic, pneumogastric, and superficial cardiac nerves; posteriorly, trachea, a little above its bifurcation, œsophagus, thoracic duct, left recurrent laryngeal, and sympathetic nerves, vertebral column, and longi colli; superiorly, arteria innominata, left carotid, and subclavian; and inferiorly, recurrent laryngeal, ductus arteriosus, right pulmonary artery, left bronchial tube, left auricle, bronchial glands, and cardiac plexus, which is likewise slightly posterior to it; all those several parts may be be said to lie within the arch.

Relations of Descending Portion.—Anteriorly, constituents of the

root of left lung; posteriorly, vertebral column, and origin of left longus colli, with sympathetic nerve; to its right side, œsophagus and thoracic duct; and to its left, the pleura.

Remarks.—In looking to the arch itself, there are certain points given which appear in some measure to define the several portions that we have just described; thus between the ascending and transverse portions, the origin of the arteria innominata has been suggested as the termination of the one, and the commencement of the other. The line of demarcation between the transverse and descending portions is however, indicated more fully; as, for instance, by the ductus arteriosus, and passage of the left bronchus below, origin of left subclavian above, and ascent of left recurrent behind, while the point of distinction between the descending portion, and thoracic aorta is mapped out by the origin of the first intercostal from the latter; but in stating these limits we are fully aware that they are not critically correct.

The aorta at its commencement possesses some peculiarities, which we will now proceed to enumerate:—1. It is remarkable for the aortic annulus from which it springs, forming a ring much more constricted than the calibre of the vessel itself, and presenting a figure more or less triangular, depending on the three roots from which it arises. 2. It exhibits valves at its origin, structures which no other true artery possesses. 3. Its walls are rendered irregular by the existence of those ampullar dilatations known as the sinuses of Valsalva. 4. According to Malgaigne, it has an additional coat between its middle and internal, called the sclerous. 5. It forms a perfect arch or syphon, and is expanded into a capacious bulb at the junction of the descending with the transverse portion (great sinus of Morgagni). With respect to this last feature in its character, it must not be supposed that this bulb exists at all periods of life, as it is altogether absent in the infant, and at this time a considerable interval exists between the sternum and the ascending portion, no doubt depending in a great measure on the presence of the thymus gland; but as puberty approaches, the dilatation gradually makes its appearance, and increases in size with each succeeding year, until at length it becomes so far expanded as to reach the sternum, which is frequently absorbed by its pressure, a polished and deep excavation corresponding to its progressive effects being occasionally visible. In advanced life likewise, the upper part of the arch is always nearer the fourchette of the sternum, than at the middle period, a position resulting from this expansion; and in the infant also, it is similarly placed, from the non-development of the sternum; and here we may likewise add, that, according to our observations, the same peculiarity is present in the female, from the comparatively diminished capacity of the thorax from above downwards.

Anomalies.—This is a copious subject with respect to this vessel, the most remarkable being that of the transposition of the entire arch, where it embraces the root of the right, and not of the left lung. Examples of this anomaly are however, very rare, and are usually accompanied by a transposition, not only of the veins, but likewise of all the other viscera of the body. Again, after its origin, the aorta may proceed for a short distance, and then divide into an ascending and descending trunk—the former for the supply of the head and upper extremity, and the latter for that of the lower, as in the horse. The aorta may also bifurcate, at the junction of its ascending and transverse portions, and having encircled the œsophagus and trachea, as in reptiles, may again unite at the spine; or it may also arise in common with the pulmonary artery, and thus prove a cause of cyanosis.

With respect to the branches which arise from the arch, they may be either anomalies from deficiency, anomalies from redundancy, or anomalies from transposition of its branches. In the first instance, there may be only two branches; and in that case the left carotid almost invariably arises from the innominata, or the left subclavian and carotid may form a common trunk; in the second, there may be four branches, the left vertebral being usually the supernumerary. A very curious example of this anomaly has been recorded, where there was no common carotid, but the internal and external carotid arteries arose separately from the arch (see Dr. Power's work on *Arteries*, pp. 34, 35). In some cases there may be five branches, the additional being the left vertebral, with the internal mammary or superior intercostal, or inferior thyroid or deep cervical; but we have never observed an instance where more than five sprang independently from the arch, although we are aware such has been described. In the anomaly by transposition, we usually find both carotids arising by a common trunk, on either side of which is a subclavian, or both subclavians may spring from the left extremity of the arch, the carotids still arising from a common trunk.

Again, from what we have observed in the course of our dissections, we are strongly disposed to believe that the middle thyroid artery, described by Neubauer, is more frequently found to exist than is generally supposed, and that its very minute size, as it springs from the transverse portion of the arch, causes it to be often overlooked.

COLLATERAL BRANCHES OF THE ARCH OF THE AORTA

Consist of—1. The right coronary; 2. Left coronary; 3. Arteria innominata; 4. Left carotid; and 5. Left subclavian.

1. Right Coronary, arises from the anterior and right side of the

arch of the aorta, between the infundibulum and right auricle. It passes backwards and downwards, through the right auriculo-ventricular furrow, till it reaches the upper part of the posterior ventricular groove, along which it runs to the apex of the heart, where it anastomoses with the left coronary, with which however, it had previously communicated, by a cross branch, at the point where it enters the ventricular furrow.

2. Left Coronary, arises from the anterior and left side of the aorta, above the margin of the sigmoid valve, and passing downwards and towards the left side, between the infundibulum and left auricle, enters the anterior ventricular furrow, through which it runs to the apex of the heart, to anastomose with the right; as it enters the ventricular groove it throws off a large branch, which winds around the base of the left ventricle, through the left auriculo-ventricular groove, also to anastomose with the right.

Remarks.—From this arrangement, it will be observed that the heart is surrounded by two arterial zones, one of which encircles it from above downwards, and the other from side to side. From these zones, branches are given off to the walls of the auricles and ventricles, and also to the septum, and origins of the great arterial trunks. In their course along the furrows of the heart these arteries are always enveloped in fat.

Anomalies.—They may arise by a common trunk, or they may be three, or even four, in number.

ANTERIA INNOMINATA

Arises from the junction of the ascending, with the transverse portions of the arch of the aorta, opposite the cartilage of the second rib of the right side, and passing upwards, forwards, and outwards, terminates a little above the right sterno-clavicular articulation, by dividing into the right carotid, and right subclavian.

Relations.—Anteriorly, first bone of sternum, origin of sterno-hyoid and thyroid muscles, deep cervical fascia, remains of thymus gland, and left vena innominata; posteriorly, the trachea; to the right side, right vena innominata, pneumogastric and phrenic nerves, cone of the pleura, and apex of the lung; and to the left, the left carotid, but separated from it by a triangular interval, in which is apparent the trachea, and some loose areolar tissue, with the descending thyroid veins.

Remarks.—This artery varies in length from one to two inches, and usually rises higher in the neck of the female than of the male, owing to the shortness of her thorax in a vertical direction. At its point of bifurcation into carotid and subclavian, it is usually slightly

dilated, the former vessel always being on the most anterior plane, and slightly overlapping the latter. To the right side of this artery a very remarkable quadrilateral space exists, circumscribed on every side by blood vessels; bounded on the right, by the right vena innominata; on the left, by the arteria innominata; above, by the subclavian artery; and below, by the left vena innominata. Within it are two nerves, the right pneumogastric, and its recurrent branch, and through it, the point of the aneurism needle must pass in the attempt to secure either the arteria innominata, or the right subclavian, in its first stage.

Branches of Arteria Innominata.—Are two only, the right carotid, and right subclavian.

Common Carotid, arises from the arteria innominata a little above the right sterno-clavicular articulation; it passes upwards, backwards, and outwards, and terminates at the upper edge of the thyroid cartilage, opposite the lower edge of the third cervical vertebra, by dividing into the external, and internal carotids.

Relations.—Anteriorly, integument, platysma, superficial fascia, communicating branch of anterior with external jugular vein, sterno-mastoid, hyoid, thyroid, and omo-hyoid muscles, deep cervical fascia, superficial branch of superior thyroid artery, transverse thyroid veins, and descendens noni nerve; posteriorly, longus colli, and rectus capitis anticus major, inferior thyroid artery, recurrent and sympathetic nerves; externally, internal jugular vein, and pneumogastric nerve; and internally, trachea, œsophagus, inferior constrictor of pharynx, termination of recurrent, and inferior thyroid artery, with lobe of thyroid body, which occasionally overlaps it, especially on the left side.

Left Carotid, arises from the transverse portion of the arch of the aorta, opposite the second dorsal vertebra, but takes a similar course, and terminates at the same point as the right; it consequently, in the first part of its course, for about one inch and a half, lies within the cavity of the thorax, and has the following additional relations:—Anteriorly, first bone of sternum, origins of sterno-hyoid and thyroid muscles, deep cervical fascia, remains of thymus gland, and left vena innominata; posteriorly, trachea, œsophagus, and thoracic duct; externally, pneumogastric and phrenic nerves, and formation of left vena innominata; externally and posteriorly, left subclavian; and internally, arteria innominata, with the triangular interval, containing the trachea, and the inferior thyroid veins.

Remarks.—Both the carotid and subclavians on the left side, although longer in their course, are smaller in calibre than those on the right, a state, according to Bichat, resulting from the more frequent use of the right side of the body. It should be borne in mind,

that the carotids, although comparatively near to each other at their origin, gradually diverge as they ascend, so that a considerable interval exists between them at their termination; the left is also nearer the mesial line, and is consequently more closely related both to the œsophagus and its corresponding pneumogastric nerve, and more overlapped by the left lobe of the thyroid body. A common sheath invests the artery, vein, and nerve, on both sides, but the nerve is always in closer connexion with the vein than with the artery. We have in the general description, stated the point where these arteries usually terminate; but it should be recollected, that cases frequently occur where they may bifurcate either above, or below, the upper edge of the thyroid cartilage; but it is a general rule, that their division into external, and internal carotids, is always nearer the angle of the jaw in the adult, than in the very young or very old, for the obvious reason of the non-development of the angle at those periods of life. Both carotids are very superficial in the upper part of their course, as they lie in the superior anterior triangle of the neck, being there merely covered by the skin, platysma, and superficial fascia; their average length is from three inches and a half to four inches.

Anomalies.—The right carotid may occasionally arise, as a separate branch, from the arch of the aorta, or by a common trunk, with the left carotid; but the left may not only arise as already indicated, but also in common with the left subclavian, forming, in fact, a left arteria innominata; also the common carotid may be altogether absent, the external and internal, both springing separately from the arch of the aorta (Power). The point of their bifurcation may be likewise very high, as already stated; and we have seen it more than once extending even higher than the angle of the jaw, before its division took place; but in those examples, the superior thyroid always sprung from the common carotid, previous to its bifurcation.

EXTERNAL CAROTID.

Arises from the common, opposite the upper edge of the thyroid cartilage, and ascends at first upwards, and slightly inwards, as far as the posterior belly of the digastric; it then passes upwards, backwards, and outwards, and terminates in the parotid gland, half an inch below the zygoma, and a little posterior to the condyle of the lower jaw, by dividing into internal maxillary, and temporal.

Relations.—Anteriorly, integument, platysma, forming the musculus risorius of Santorini in the parotid region, superficial fascia, lingual nerve, stylo-hyoid, and digastric muscles, portio dura, and formative branches of the external jugular vein; posteriorly, glosso-

pharyngeal nerve, stylo-pharyngeus, and stylo-glossus muscles, point of styloid process, stylo-hyoid ligament, and ascending palatine artery, all of which separate it from the internal carotid ; the superior laryngeal nerve also lies behind it; externally, internal carotid, sterno-mastoid, and external auditory meatus; and internally, thyroid, lingual, and facial arteries, the stylo-maxillary ligament separating it from the latter, while above the angle of the jaw it is invested on all sides by the parotid gland.

Remarks.—From what has been stated with respect to the direction of this artery, it will be at once seen that it forms in its course a curve, representing a limited segment of a circle, the concavity of which looks downwards, backwards, and outwards, and although very superficial at its origin, it becomes more deeply situated as it ascends, being protected by the angle of the jaw, which is in a great measure calculated to defend it from injury; its average length is three inches.

Anomalies are rare in the external carotid, but still cases occur where it might almost be said to be absent, as in the following instance, which we have had an opportunity of observing. The common carotid bifurcated regularly at the thyroid cartilage, but while the internal carotid ran its usual course, that which represented the external ascended only a line or two, and then broke up into its several branches, each pursuing its ordinary direction ; the appearance of this anomaly, when dissected, was extremely beautiful.

BRANCHES OF THE EXTERNAL CAROTID.

Besides those which it gives off to the tympanum, and parotid, which are very variable in size and number, it likewise throws off ten others which are always capable of demonstration; these have been divided into anterior, posterior, transverse, and ascending—the first, or anterior, consisting of three, viz., superior thyroid, lingual, and facial ; the second, or posterior, also of three, viz., muscular, occipital, and posterior auricular; the third, or transverse, of two, viz., the transverse facial, and internal maxillary; and the fourth, or ascending, also of two, viz., ascending pharyngeal, and temporal.

(A.) *Anterior Branches of the External Carotid.*

I. SUPERIOR THYROID.

The first branch given off by the external carotid from its internal side after its origin, may be divided into two stages—a transverse, reaching in a curved direction, and with the convexity di-

rected upwards, from its parent trunk to the side of the larnyx; and a vertical, extending from the latter point to the thyroid gland.

Relations—First Stage.—Anteriorly, integument, platysma, superficial fascia, formative branches of the anterior jugular vein, and twigs of the descendens noni to the sterno-hyoid and omo-hyoid muscles; posteriorly, loose areolar tissue, and superior laryngeal nerve, separating it from the longus colli muscle.

Second Stage.—Anteriorly, omo-hyoid, and near its termination, sterno-thyroid; posteriorly, upper portion of sterno-thyroid and then winding beneath its external margin, thyroid origin of the inferior constrictor. On reaching the lobe of the thyroid body, it divides into three branches—an external, which runs on the outside of the thyroid gland, and anastomoses with the inferior thyroid; a middle, which perforates the substance of the gland, and breaks up into numerous ramusculi for its supply; and an internal, which runs on its inner side towards the middle line, supplies the middle lobe, and sends a branch across the crico-thyroid space, to anastomose with a similar one from the opposite side; this also sometimes gives off a small laryngeal branch.

Collateral Branches of Superior Thyroid are hyoid, muscular, and laryngeal.

1. Hyoid Branch.—Is always very small, and springs from the artery immediately after its origin; it passes forwards and inwards between the thyroid muscle and ligament, below the cornu of the os hyoides, and in the middle line anastomoses with that from the opposite side, and with a similar branch from the lingual.

2. Muscular Branch.—Small and slender, arising close to the last; it passes downwards and outwards, over the sheath of the great vessels, and beneath the sterno-mastoid, to which, and the adjoining glands, it is distributed.

3. Laryngeal Branch.—Usually large, arises from the thyroid at the angle of flexion, between its first and second stages, passes inwards, at first between the middle and inferior constrictors, with the superior laryngeal nerve, then between the thyro-hyoid muscle and membrane, perforating the membrane, or sometimes the thyroid cartilage, and beneath the mucous membrane divides into two branches—an ascending, to supply the epiglottis, and aryteno-epiglottidean folds; and a descending, which runs downwards, to be distributed to the lining membrane of the larynx and trachea.

Remarks.—The size of the superior thyroid is very variable, and seems to depend, in a great measure, on the capacity of the inferior thyroid, it being generally observed, that where the one is extremely large, the other is relatively small, a fact which would appear to argue strongly against the use of the ligature in affections of the thyroid gland.

Anomalies.—This vessel, as the rule, may be said to arise immediately below the cornu of the os hyoides, but exceptions will occur, when it may come off either some distance above or below that point, in the latter instance its origin being usually from the common carotid. It may also arise by a single trunk, in common with the lingual, or its laryngeal branch may proceed separately from the external carotid.

II. LINGUAL ARTERY.

Arises from the external carotid, a little above the superior thyroid, the cornu of the os hyoides separating them at their origins, and terminates at the under surface of the tip of the tongue. It has been divided into three stages—the first transverse, but slightly curved, with the convexity, like the last, directed upwards, from its origin till it passes beneath the hyoidean attachment of the hyo-glossus; the second, vertical, while it lies beneath that muscle; and the third, also transverse, as it runs along the under surface of the tongue, where it communicates with its fellow only.

Relations—First Stage.—Anteriorly, integument, platysma, superficial fascia, posterior fibres of hyo-glossus, and thyroid branch of lingual nerve; anteriorly and superiorly, tendon of digastric, stylo-hyoid muscle, and lingual nerve, which runs parallel to it, but separated from it by the posterior fibres of the hyo-glossus; inferiorly, cornu of os hyoides; and posteriorly, superior laryngeal nerve, some loose areolar tissue, and a few fibres of origin of the middle constrictor. In this stage it lies in a quadrilateral space, very limited in size from above downwards; bounded posteriorly, by the external carotid; internally, by the posterior edge of the hyo-glossus; above, by the tendon of the digastric; and below, by the cornu of the os hyoides.

Second or Vertical Stage.—Anteriorly, integuments, platysma, fascia, anterior belly of digastric, mylo-hyoid, hyo-glossus, and lingual nerve, which here crosses it, to become internal to it; posteriorly, middle constrictor; and, at its termination, mucous membrane of mouth.

Third Stage, or Ranine.—Superiorly, muscular tissue of tongue; inferiorly, mucous membrane, ranine veins, and branches of gustatory nerve; internally, genio-hyo-glossus; and externally, prolonged lingual fibres of the hyo-glossus.

Collateral Branches.—Hyoid, dorsalis linguæ, and sublingual.

1. Hyoid.—Very small; arises immediately after the origin of the lingual, and passes forwards superficially, on the upper edge of the cornu of the os hyoides towards the mesial line, to anastomose with a similar branch of the opposite side, and with the hyoidean of the thyroid.

2. Dorsalis Linguæ, arises from the lingual, while that artery lies under the posterior fibres of the hyo-glossus, beneath which, and in front of the anterior pillar of the fauces, it passes upwards to the side, then to the dorsum, of the tongue, forming an arch towards its posterior part, supplying its papillæ, and distributing branches to the soft palate, which anastomose with others in the same region from the internal maxillary.

3. Sublingual, always a large branch, given off at the junction of the second and third stages, passes inwards, between the mylo-hyoid and genio-hyo-glossus, and at the sublingual gland throws off numerous branches to supply that structure, while the continued trunk runs upwards and inwards, forming an arch with its fellow of the opposite side, above the frænum, and behind the symphysis, from which several twigs proceed for the supply of the teeth.

Remarks.—The lingual artery is sometimes exceedingly large, and at the same time remarkable for its tortuosity; it is also variable in its relations to the middle constrictor, occasionally passing between its slips of origin from the cornu and appendix of the os hyoides, and occasionally being superficial to both. In its termination as the *ranine* artery, its filaments are very numerous, slender, and long, supplying both the muscles and mucous membrane.

Anomalies.—The lingual artery frequently arises by a common trunk with the facial, but very rarely with the thyroid. Its branch, the sublingual, is very often absent altogether, and in that case the sublingual gland always receives a large branch from the submental of the facial, which pierces the mylo-hyoid in order to reach it.

III. FACIAL ARTERY.

Arises a little above the lingual, from the inner side of the external carotid, and passes at first upwards and inwards, till it reaches the inner side of the angle of the jaw; then turns horizontally forwards beneath its ramus for about an inch, when it winds abruptly upwards and outwards, over its inferior margin, and continues its very tortuous course on the face, as far as the internal canthus of the eye. Hence it has been divided into two stages—a cervical, and a facial, in each of which it may be separately examined.

Relations of Cervical Stage.—Anteriorly, integument, platysma, fascia, lingual nerve, digastric and stylo-hyoid muscles, facial vein, and a small process of the submaxillary gland; posteriorly, stylo-pharyngeus, stylo-glossus, glosso-pharyngeal nerve, submaxillary gland, and posterior edge of mylo-hyoid muscle; externally, stylo-maxillary ligament, and insertion of internal pterygoid; and internally, it embraces the submaxillary gland, which lies within its concavity.

Facial Stage.—Anteriorly, integument, platysma, fascia, some fibres of the triangularis oris, levator labii superioris alæque nasi, and zygomatic muscles, and above, a variable mass of fat, with branches of portio dura ; posteriorly, ramus of jaw, buccinator, levator anguli oris, and ultimately nasal process of superior maxillary bone. Its accompanying vein, which is very large, lies in its entire course to its outside, and is void of that tortuosity which distinguishes the artery.

Collateral Branches.—Those in the cervical stage are—palatine, tonsillary, glandular, and submental; those in the facial—masseteric, labial, inferior and superior coronary, nasal and angular, or terminating.

1. Palatine.—Generally very small, and usually arising in common with the tonsillary, immediately after the origin of the facial ; it passes upwards, backwards, and inwards, between the stylo-glossus and stylo-pharyngeus, and between the external and internal carotid arteries, and reaching the superior constrictor of the pharynx, which it perforates, supplies the velum, and anastomoses with the proper palatine arteries from the internal maxillary.

2. Tonsillary.—Variable in size ; arises generally in common with the palatine, passes upwards and inwards between the stylo-glossus and internal pterygoid, into the pterygo-pharyngeal space, perforates the superior constrictor, and is distributed to the tonsil, anastomosing with branches from the palatine.

3. Glandular.—Three or four branches, distributed to the submaxillary gland.

4. Submental.—Always large; arises from the facial, immediately before the termination of its cervical stage, and passes forwards and inwards, beneath the ramus of the jaw, and on the upper margin of the mylo-hyoid muscle, where it divides into three branches—a superior, middle, and inferior: the first, winding upwards over the ramus of the jaw, to anastomose with the labial ; the second, dividing on the front of the chin into numerous ramusculi, which supply that region ; and the third, piercing the mylo-hyoid muscle, to anastomose with the sublingual of the lingual.

5. Masseteric.—Very irregular as to number and size; arise from the facial, immediately after it crosses the ramus of the jaw, and, passing outwards, supply the masseter muscle, anastomosing with similar twigs from the external carotid.

Inferior Labial, small, but very constant in its appearance, arises from the facial, immediately after it ascends above the ramus of the jaw ; it passes inwards, and divides into three sets of branches, one which winds upwards, to anastomose with the coronary ; a second that descends, to unite with the subl~~ingual~~; and a third that runs

directly inwards to anastomose with its fellow of the opposite side.

7. CORONARY, are two in number—superior and inferior, the former being always the larger; they arise opposite the angle of the mouth, and run forwards and inwards, on the posterior margin of the lips, where they are merely covered by fine integument; they are remarkable for their tortuosity, as well as for their free inosculation, while from the arch formed by the two superior, rather a large branch (arteria septi nasi) is given off, for the supply of the mucous membrane of the septum of the nose.

8. LATERALIS NASI, arises generally opposite the lower border of the nose, and, passing inwards, ramifies on the compressor nasi, anastomosing with its fellow of the opposite side, and with the nasal of the ophthalmic.

9. ANGULAR, the terminal branch, and nothing more than a slender twig; it runs upwards and inwards, at first between the two heads of the levator labii superioris alæque nasi, then between the inner head of that muscle and edge of the orbicularis palpebrarum, to the internal canthus of the eye, where it anastomoses with the frontal and nasal of the ophthalmic.

Remarks.—The facial artery, remarkable both for the length of its course and its tortuosity, forms in one respect a striking contrast to its vein, which is almost perfectly straight, and which lies to its outer side. We have occasionally observed this artery completely obliterated as it passed over the ramus of the jaw, but its facial portion was still pervious to blood, which it received from its numerous anastomoses with the various branches in that region. In its cervical stage, we have been accustomed to describe a triangular space, bounded in front by the facial, behind by the external carotid, and above by the ramus of the jaw which constitutes its base, the extent of the space being a little better than an inch in width, and here an incision for subfascial cervical abscess may be made with comparative safety,—a fact in surgical anatomy, that was recently tested by Dr. Butcher, with complete success.

Anomalies.—It repeatedly arises in common with the lingual, and may terminate at the angle of the mouth, by dividing into the two coronaries. Under these circumstances, the transversalis faciei is always unusually large, and supplies its remaining branches.

(B.) *Posterior Branches of External Carotid.*

IV. MUSCULAR BRANCH.

Arises about half an inch above the bifurcation of the common carotid, and passes horizontally backwards, to terminate in the sterno-mastoid muscle.

Relations.—Anteriorly, integument, platysma, and fascia; posteriorly, internal carotid, pneumogastric nerve, and internal jugular vein.

Remarks.—Is usually very small, so much so that it is sometimes difficult to be demonstrated; it appears to be exclusively devoted to the sterno-mastoid muscle.

Anomalies.—It occasionally arises in common with the occipital, and in many instances the lingual nerve winds around it, and not around the occipital artery.

V. OCCIPITAL.

Arises from the external carotid, about an inch above its bifurcation; it passes upwards, backwards, and outwards, to the posterior part of the scalp, where it terminates by dividing into two branches—an internal, and external, which anastomose with each other, and with the temporal, and posterior auricular. The occipital has been divided into three stages—the first, extending from its origin to the inner edge of the rectus capitis lateralis; the second, while it crosses over that muscle; and the third, from its outer border to its ultimate termination.

Relations—First Stage.—Externally, integument, platysma, fascia, and digastric muscle; internally, it crosses the lingual nerve, internal carotid, pneumogastric, and spinal accessory which separates it from the internal jugular vein; while above it, is the parotid, a small process of which sometimes surrounds it.

Second Stage.—Externally, integuments and fascia, sterno-mastoid, splenius, trachelo-mastoid, and origin of digastric; internally, rectus capitis lateralis, which divides it from the vertebral artery; superiorly, mastoid portion of temporal bone; and inferiorly, transverse process of atlas.

Third Stage.—Externally, aponeurosis of splenius, and a few fibres of complexus, and trapezius; internally, occipital attachment of superior oblique, edge of rectus capitis posticus major, and deep portion of complexus.

Collateral Branches.—Posterior occipito-meningeal, and princeps cervicis.

1. Posterior Meningeal, or Occipito-meningeal, always given off in the first stage; it passes upwards, through the posterior lacerated hole, in company with the spinal accessory nerve, and ramifies in the occipital fossa, anastomosing with the posterior branch of the middle meningeal.

2. Princeps Colli, is generally a large branch, which arises from the occipital in its third stage, and passes downwards and inwards,

between the complexus and semispinalis colli, to anastomose with the cervicalis profunda of the subclavian.

Remarks.—The occipital artery is usually very regular in its course, but may occasionally exhibit some variations. Thus it sometimes runs completely through the parotid gland, or again may be half-an-inch below it. In its third stage, it generally divides into two branches, one of which passes superficial to, and the other deeper than, the occipital attachment of the splenius; the latter is generally accompanied by the great occipital nerve, which lies internal to it.

Anomalies.—It may arise by a common trunk with either the muscular or posterior auricular, or as a branch of the internal carotid; or it may terminate on the rectus lateralis, when the continuation of the cervicalis ascendens will give off its ultimate branches to the posterior part of the scalp. In more than one instance we have observed it lying immediately beneath the skin and fascia; and running superficial to all the muscles, which in its regular condition overlap it, but there certainly was a small delicate twig pursuing the course which in its normal state it ought to have followed.

VI. POSTERIOR AURICULAR.

Arises a little above the last in the substance of the parotid gland, and passes upwards, backwards, and outwards, to terminate in the integument of the ear and the parts immediately posterior to it, anastomosing with the occipital, and temporal.

Relations.—Externally, digastric muscle, portio dura, and a process of the parotid gland; internally, parotid gland, spinal accessory nerve, and mastoid process.

Collateral Branches.—Muscular, and stylo-mastoid.

1. Muscular.—A few twigs to the digastric, sterno-mastoid, and splenius.

2. Stylo-mastoid.—Small, but very constant; runs backwards directly on the inner border of the portio dura, enters the stylo-mastoid hole, and following the tortuous course of the aqueduct of Fallopius, meets with the Vidian branch of the middle meningeal, with which it anastomoses. It is said to give branches to the internal ear, but this we have never as yet had an opportunity of observing.

Remarks.—The posterior auricular is very variable as to size, but is seldom if ever absent. In a well-injected subject its distribution to the pinna can be clearly observed, as it supplies its several parts, especially the auditory meatus and the fossa innominata, between the helix and anti-helix.

Anomalies.—It is often derived from the occipital.

(C.) *Transverse Branches of External Carotid.*

VII. TRANSVERSE FACIAL

Arises in the substance of the parotid gland from the termination of the external carotid, passes horizontally forwards on the side of the face, and terminates by anastomosing with the infra-orbital, and the proper facial.

Relations.—Externally, integument, platysma, fascia, and socia parotidis, when it exists; internally, masseter and fat between it and buccinator; superiorly, zygomatic arch, and inferior margin of malar bone; and inferiorly, Steno's duct.

Remarks.—This artery, in its course across the masseter, is accompanied by the buccal branch of the portio dura, which is sometimes found above, and sometimes below it. In some cases this vessel is very large, and under those circumstances it is observed to take the place of the terminal portion of the facial, which terminates, as already described, at the angle of the mouth; in this instance, the transverse facial gives off its two terminal branches—the lateral nasal, and angular; and sometimes both coronaries.

Anomalies.—It is as often a branch of the temporal, as of the carotid trunk.

VIII. INTERNAL MAXILLARY.

The true terminal branch of the external carotid arises about half-an-inch below the zygoma, and passes at first downwards, forwards, and inwards, internal to the jaw; then runs horizontally forwards between the two pterygoid muscles; next winds upwards, forwards, and inwards, crossing between the insertions of the temporal and external pterygoid, then between the two heads of origin of the external pterygoid and at last enters the pterygo-maxillary fossa, where it breaks up into its terminal branches. Hence it has been divided into three stages, the first extending from its origin to the inner margin of the internal lateral ligament, the second while it lies in the pterygoid space, and the third while it occupies the pterygo-maxillary fossa.

Relations—First Stage.—Externally, ramus of jaw and edge of masseter muscle; internally, styloid process of temporal bone, internal lateral ligament, and internal pterygoid muscle; superiorly, temporo-maxillary articulation; and inferiorly, convergence of internal lateral ligament, with vertical ramus of jaw.

Second Stage.—Externally, ramus of jaw and temporal muscle; internally, dental and gustatory nerves; superiorly, external pterygoid; inferiorly, internal pterygoid; and anteriorly, buccinator muscle. Here, in fact, it lies on the boundaries of the pterygoid fossa.

Third Stage.—It lies in the pterygo-maxillary fossa, the boundaries of which have been already described, with the base of the cranium, and while in this space, it is in company with Meckel's ganglion, enveloped in a quantity of fat, and close to the nasal plate of the palate bone.

Collateral Branches.—These in the first stage are, tympanic, middle meningeal, and inferior dental; in the second, temporal, masseteric, pterygoid, buccal, and superior dental; and in the third, spheno-palatine, posterior palatine, Vidian, and infra-orbital.

1. Tympanic, are a series of minute twigs which enter the tympanum, by the Glaserian fissure, for the supply of its mucous membrane.

2. Middle Meningeal, arises from the upper part of the artery, as it lies internal to the neck of the jaw; it passes upwards and inwards, at first on the outside of the internal lateral ligament, which, as it ascends, it gradually pierces and becomes internal to it; it then passes between the insertion of the external pterygoid and temporo-maxillary articulation on the outside, and the Eustachian tube and levator palati on the inside, having the inferior maxillary nerve in front of it, and the origin of the internal lateral ligament behind it, to all of which it distributes branches; it then runs between the two roots of origin of the temporo-auricular nerve, and entering the cavity of the cranium through the spinous hole, divides into two sets of branches—an anterior, and posterior; the former, passes upwards and forwards, grooving in succession the sphenoid and parietal bones, a complete canal sometimes existing in the latter for its reception, until it reaches the middle line of the vault of the cranium, where it ultimately anastomoses with its fellow of the opposite side, and with the anterior meningeal from the ascending pharygeal; in its course it throws off a large branch, sometimes more, which enters the orbit through the external angle of the foramen laccrum orbitale, runs along the outer wall of that cavity, where some of its twigs, perforating the bone, anastomose with the temporal, while it terminates itself in the lachrymal gland, by communicating with the proper artery of that structure. The posterior branch of the middle meningeal winds backwards, indenting the squamous plate of the temporal bone, and anastomosing with the posterior meningeal from the vertebral, or occipital. Besides those branches which are given off for the supply of the dura mater and bone, it likewise distributes several smaller ones to the Casserian ganglion, as well as a very constant offset which passes directly backwards, beneath that ganglion, and accompanies the Vidian nerve into the aqueduct of Fallopius, where it anastomoses with the stylo-mastoid branch of the posterior auricular.

3. Inferior Dental, arises from the lower part of the internal maxillary a little anterior to the middle meningeal; it passes downwards and outwards between the ramus of the jaw, and internal lateral ligament, and behind the inferior dental nerve; as it enters the dental hole, it throws off a minute filament to accompany the mylo-hyoid nerve to the posterior border of the mylo-hyoid muscle, and then continues its course through the dental canal, distributing numerous branches to the fangs and pulp of each tooth, till it reaches the mental hole, where it divides into two branches—incisive, and mental; the former, runs along the roots of the anterior teeth, and ultimately anastomoses with its fellow of the opposite side; while the latter, emerges through the mental hole, between the quadratus menti and triangularis oris, and spreading out into a star of branches, supplies the mucous membrane and muscles, ultimately anastomosing with the coronary, labial, and submental.

4. Temporal, usually double, arise opposite the sigmoid notch of the lower jaw, and pass vertically upwards, piercing the attachments of the external pterygoid and temporal muscles to the crest of the great wing of the sphenoid; they now enter the temporal fossa, and ramifying between the bone and the muscle, anastomose along its anterior and posterior margins, with the middle branch of the superficial temporal and the perforating twigs of the middle meningeal.

5. Masseteric.—Generally very small, passes directly outwards through the sigmoid notch, occasionally piercing the lower fibres of the external pterygoid, then bends downwards between the ramus of the jaw and the masseter, and enters that muscle, to which it is distributed, anastomosing with branches of the facial.

6. Pterygoid.—Several small, short twigs, variable in number, which are distributed to the pterygoid muscles.

7. Buccal.—A small but long branch; it runs forwards through the upper part of the pterygoid space, along the inferior margin of the external pterygoid, to the buccinator muscle, and on it, anastomoses with the facial.

8. Posterior Dental, is usually a very large branch, given off at the tuber maxillare, down which it descends for some distance very tortuously, and then divides into three branches—an external, middle, and internal: the first runs along the alveoli, supplying the periosteum and mucous membrane of each alveolus; the second pierces the tuber, and distributes its branches to the roots of the molar teeth; while the third, enters the antrum of Highmore, where its filaments ramify between the lining mucous membrane and the osseous walls of the cavity.

9. Posterior Palatine, arises from the internal maxillary, in the pterygo-maxillary fossa; it immediately bends downwards, through

the posterior palatine canal, and emerging on the hard palate, divides into two principal branches—a posterior, which supplies the soft palate and tonsils, anastomosing with its fellow of the opposite side, and with the sublingual; and an anterior, which curving along the hard palate, internal to the alveolar arch, and covered by the mucous membrane, reaches the foramen incisivum, where it anastomoses with its fellow, and septal branches of the spheno-palatine.

10. Vidian.—Always a mere filament, which passes backwards and outwards in company with the nerve of the same name, and is expended on the base of the cranium, in supplying the Eustachian tube; it anastomoses with twigs from the ascending pharyngeal.

11. Spheno-palatine.—This, both from its size and direction, ought to be considered as the continuation of the internal maxillary: it proceeds directly inwards, through the spheno-palatine hole, into the posterior part of the superior meatus, and divides into a network of branches which supplies the spongy bones, while one or two long filaments always accompany the nerve of Cotunnius, to the incisive fossa, to anastomose with the posterior palatine.

12. Infra-orbital.—Variable in size; it passes directly forwards, crossing the spheno-maxillary fossa, through which it sends up numerous twigs, for the supply of the fat and muscles of the orbit, while before it emerges through the infra-orbital hole, it gives off filaments to the anterior part of the antrum. On the face it lies between the levator anguli oris and outer head of the levator labii superioris alæque nasi, and here divides into three sets of branches—internal, middle, and external; the first, proceeds towards the nose, and anastomoses with the facial; the second, passes upwards to the inferior eyelid, and unites with the proper palpebral; while the third, runs outwards, towards the malar bone, to communicate with the transverse facial.

Remarks.—The internal maxillary is justly considered one of the most difficult of the branches of the external carotid; this difficulty depending not only on its tortuous course and numerous important relations, but likewise on an irregularity to which it is very liable. Cases are of frequent occurrence, where, in its second stage, it does not occupy the pterygoid space at all, but dipping deeply beneath the external pterygoid, enters the pterygo-maxillary fossa from within outwards, or, under cover of that muscle; generally perforating the attachment of its inferior head to the pterygoid plate. In this instance, we would in vain look for it between the tendons of the temporal and external pterygoid, anterior to the neck of the jaw; but in this situation, we will always find a small branch, its representative, usually terminating in the temporal and masseteric. In the pterygoid space, the internal maxillary always

lies superficial to the gustatory and dental nerves, and never, according to our observation, deeper than them. Neither does it ever pass through the triangular space, intercepted between those two nerves and the communicating branch between them; it crosses over it, no doubt, but never through it.

Anomalies.—Very rare, but it has been remarked that it sometimes springs from the facial; such an occurrence we have never witnessed, and therefore, cannot vouch for the truth of the statement.

(D.) *Ascending Branches of External Carotid.*

IX. PHARYNGEA ASCENDENS

Arises from the external carotid as it bifurcates from the common carotid; it passes almost vertically upwards, to the base of the cranium, and divides into two branches—a posterior (meningeal), which enters the cerebral cavity through the foramen lacerum posterius, where it anastomoses with the posterior meningeal; and an anterior (pharyngeal), which supplies the muscles of the pharynx, and Eustachian tube, communicating with the tonsillary, inferior palatine, and Vidian.

Relations.—Anteriorly, external carotid, and the superior constrictor, that muscle being also internal to it; posteriorly, rectus capitis, anticus major; and externally and anteriorly, internal carotid.

Remarks.—The ascending pharyngeal is always very variable as to size, appearing to be regulated in this respect, in a great measure by the palatine of the facial, the increased capacity of the one being generally accompanied by a corresponding diminution of that of the other. Several of its smaller twigs are distributed to the nerves of this region, particularly to the superior cervical ganglion of the sympathetic, and to the pneumogastric.

Anomalies.—We have observed the pharyngeal to arise from the common carotid, immediately before its bifurcation, also from the occipital, and facial.

X. TEMPORAL.

The continuation of the external carotid in direction, but not in size; commences half an inch below the zygoma, and passing almost vertically upwards, crosses that process near its tubercle, and then, ascending for about an inch and a quarter, divides into three branches—an anterior, to anastomose with the supra-orbital; a middle, or deep, to communicate beneath the muscle with the deep temporal; and a posterior which winds backwards, above the concha, to anastomose with the posterior auricular and occipital.

Relations.—Anteriorly, integument, fascia, and attrahens aureum muscle; and posteriorly, temporo-auricular nerve, temporal bone, and temporal aponeurosis.

Remarks.—This artery is sometimes very large and tortuous, and always throws off one very peculiar branch,—the orbital, which runs between the layers of the temporal aponeurosis, in company with the temporo-malar nerve, and terminates in the orbicularis palpebrarum.

Anomalies.—We have never observed any.

INTERNAL CAROTID.

Arises from the common carotid trunk, opposite the upper edge of the thyroid cartilage, and terminates within the cranial cavity at the side of the body of the sphenoid bone. It has been divided into three stages—the first, extending from its origin to the base of the cranium (cervical); the second from the last point to the anterior extremity of the petrous portion of the temporal bone (petrosal); and the third to its termination (cranial). The direction of its first or cervical stage, is at first upwards, backwards, and outwards, and then upwards, forwards, and inwards, its concavity being directed forwards and inwards, or exactly the reverse of that of the external carotid.

Relations.—First, or cervical stage; anteriorly, integument, platysma, fascia, lingual nerve, mastoid, occipital, and external carotid arteries, with the superficial relations of the latter, pharyngeal and glosso-pharyngeal nerves, stylo-glossus, and stylo-pharyngeus muscles, and styloid process, and ascending palatine artery, the last five lying between it and the external carotid; posteriorly, rectus capitis anticus major, eighth, ninth, and sympathetic nerves, with superior laryngeal branch from the pneumogastric, and internal jugular vein; internally, external carotid, superior constrictor, and ascending pharyngeal artery; and externally, internal jugular vein, but separated from it above by the eighth, and ninth nerves, one of the divisions of the eighth, the spinal accessory, occasionally passing behind the vein.

Before the artery enters the bone, it makes a sharp turn forwards and inwards, and then ascends vertically, its relations at this point being:—Anteriorly, tensor palati; anteriorly and externally, Eustachian tube; externally, middle meningeal artery, internal lateral ligament of lower jaw, and temporo-maxillary articulation; internally, junction of occipito and petro-pharyngeal aponeuroseses, but separated from it by the superior cervical ganglion of the sympathetic; and posteriorly, foramen lacerum posterius, and the parts pass-

ing through it, with the lingual nerve. On entering the carotid canal, the artery pursues a very tortuous course, first ascending for about a quarter of an inch, then turning horizontally forwards and inwards, then upwards and backwards, and ultimately upwards and forwards, grooving the cartilage which fills up the anterior lacerated hole, and perforating the dura mater, where its third stage commences.

Relations—Second Stage.—On either side a large branch from the sympathetic (nervi molles); these uniting by cross branches, form a plexus around it; externally and inferiorly, bony portion of Eustachian tube; internally and superiorly, the cochlea; and superiorly, Casserian ganglion, but separated from it by a thin plate of bone, which is however, frequently deficient in advanced life, the ganglion under those circumstances lying on the vessel directly, with the intervention, only, of a fine layer of dura mater.

At the point of the petrous portion of the temporal bone, the cranial stage commences; it proceeds at first upwards and inwards, to reach the cavernous sinus, and then arches forwards, to the anterior clinoid process, from which it again bends upwards and backwards, to terminate in its cerebral branches.

Relations—Third Stage.—Internally, side of the body of sphenoid, which it grooves, and pituitary gland; externally, sixth nerve and venous membrane; anteriorly, optic nerve, and anterior clinoid process; and posteriorly, posterior clinoid process.

Remarks.—The internal carotid, from its complicated and apparently contradictory relations, is always an artery of great difficulty to the student; but he should always recollect, that at its origin it is quite superficial, being in fact, equally so with the external carotid, and to the outer side of that vessel. It should also be borne in mind, that some of its posterior relations, as for instance, the internal jugular vein, lingual, and glosso-pharyngeal nerves, though they do lie behind it at the base of the cranium, immediately afterwards change their position, as they proceed to their several destinations. Nothing in fact, but an intimate acquaintance with the several foramina in this region, as well as a familiarity with the relative situation of the parts in the pterygo-pharyngeal space, will remove the intricacies of this subject. The pterygo-pharyngeal space to which we allude, is a remarkable region, formed by the divarication of the internal pterygoid, and superior constrictor—the former bounding it externally, and the latter internally; its posterior wall is constituted by the muscles of the spine, its base by a line drawn horizontally backwards, from the angle of the jaw to the vertebral column, while its apex is at the base of the skull, corresponding, generally speaking, to the foramen commune posterius. Its contents

may be thus generally stated :—Eighth, ninth, sympathetic, pharyngeal, and superior laryngeal nerves, internal carotid, pharyngeal, tonsillary, and posterior palatine arteries, internal jugular vein, and styloid process, with the muscles attached to it. The relation of the carotid artery to the tonsil, should here be specially noted, as it lies posterior to that gland. The examination of the pterygo-pharyngeal space, is always better accomplished in the dissection of the pharynx, according to Bichat's method.

Anomalies.—These are such as have been already indicated in the several origins of the external carotid; but, in last winter, we had an opportunity of observing a very peculiar course of the internal carotid. It pursued at first, its usual direction, till it reached the base of the cranium, and then bent suddenly downwards and forwards for about an inch and a half, when it as abruptly, and at an equally acute angle, again ascended vertically to the carotid foramen. It was at first supposed, that the vessel was double, until dissection revealed its abnormal disposition.

Collateral Branches.—In its first stage, it rarely gives off any, but in the second always a tympanic branch, to anastomose with those of the external carotid, and internal maxillary, on the walls of the middle ear; also a few small filaments (arteria receptaculi), for the supply of the cavernous sinus, and Casserian ganglion; but these require no separate description. In the third stage, it throws off the ophthalmic, anterior and middle cerebral, posterior communicating, and choroid.

I. OPHTHALMIC ARTERY,

Is always a large branch, which arises from the curve of the carotid, opposite the base of the anterior clinoid process; it enters the orbit through the optic foramen, in the same sheath, but lying at first inferior, and then external, to the optic nerve, in the latter position being between the sixth nerve and external rectus, and behind the lenticular ganglion; it next crosses forwards and inwards, above the optic, and below the nasal nerve and superior rectus, then between the superior oblique and internal rectus, where it terminates by dividing into its ultimate branches.

Collateral Branches.—While external to the optic nerve, it gives off the lachrymal, and arteria centralis retinæ; while above it, the ciliary, muscular, and supra-orbital; and while internal to it, the anterior and posterior ethmoidals, nasal, frontal, and palpebral.

1. Lachrymal.—This is usually the largest branch of the ophthalmic; it passes forwards and outwards, invested in a fibrous tubule of the dura mater, in company with its corresponding nerve, till it reaches the lachrymal gland, where it breaks up into a number

of filaments for its supply; it likewise sends a long branch forwards, which pierces the broad tarsal ligament, and anastomoses on the eyelid with the superior palpebral, forming the superior palpebral arch. In cases where the lachrymal branch is small, it is always reinforced by the twig from the internal maxillary, already alluded to in the description of that artery.

2. Arteria Centralis Retinæ.—Remarkable for its very small size; it pierces the optic nerve at first, obliquely, and then, running directly through its centre, expands into a number of filaments, which radiate on the surface of the retina as far as its circumference, and form its vascular coat; a distinct branch (artery of Zinn), perforates the vitreous humour through a special canal (Cloquet), and can be traced to the posterior aspect of the capsule of the lens.

3. Ciliary Branches, may be divided into posterior, middle, and anterior; the first, or posterior, are extremely numerous, but very small; they form a complicated plexus around the optic nerve, and then, perforating the sclerotic, are distributed to the choroid, and ciliary processes; the second, or middle, are only two in number, which also perforate the sclerotic, but at some distance from the optic nerve; they then pass forwards between the sclerotic and choroid, along the horizontal axis of the eye, and bifurcate before reaching the iris, which they inclose in an arterial zone; the third, or anterior, are very short, and may arise from both the muscular and supra-orbital; they pierce the sclerotic, a little posterior to the cornea, and are also distributed to the iris.

4. Muscular.—A series of twigs, which supply the muscles in the upper part of the orbit.

5. Supra-orbital.—A large branch, which passes forwards and inwards, on the levator palpebræ, and beneath the periosteum, and ultimately emerges through the supra-orbital notch, giving off in its course, twigs to the diploe, and frontal sinuses; it then divides into two sets of branches—internal, and external, the former winding inwards to anastomose with its fellow, above the root of the nose, and the latter running outwards, to communicate with the temporal.

6. Ethmoidal.—Are two in number,—anterior, and posterior; the former, usually small, accompanies the nasal twig of the ophthalmic through the anterior orbital hole, and on reaching the cavity of the cranium divides into two branches,—one for the supply of the anterior part of the falx cerebri, and the other breaking up into numerous filaments which accompany the ramusculi of the olfactory nerve into the nose, and are distributed to the mucous membrane. The posterior ethmoidal is a much larger branch, but its destination is precisely similar to the preceding.

7. Palpebral.—Two in number, a superior, and inferior, which

emerge below the pulley of the superior oblique, and above the tendo oculi; the superior then runs outwards, between the orbicularis palpebrarum and the tarsal cartilage, as far as the external canthus, where it communicates with a branch from the lachrymal, and forms a vascular arch, from which twigs are given off to supply the upper eyelid; the inferior, generally larger, passes downwards, at first behind the tendo oculi, and then turns outwards along the lower lid, forming its arch by anastomosing with the transversalis faciei; its distribution in the lower eyelid is similar to that of the superior in the upper lid.

8. Nasal.—Always very small; it leaves the orbit between the pulley of the oblique, and tendo oculi, and having given off a small twig to the lachrymal duct, divides into two branches, one of which communicates directly with the facial, while the other descends on the dorsum of the nose to anastomose with the lateralis nasi.

9. Frontal.—Generally large; it emerges in company with the nasal, and, having thrown off a filament to the lachrymal sac, turns upwards through the fibres of the corrugator supercilii, and divides into two branches, the internal of which passes inwards, to supply the integuments of the forehead, where it communicates with its fellow of the opposite side; while the external, winds outwards, to anastomose with the supra-orbital.

Remarks.—The ophthalmic, according to our experience, is always constant in its course, and ultimate distribution; we cannot recollect an instance of any peculiarity that would deserve especial notice.

Anomalies.—The same observation may be equally applied to the origin of this vessel.

II. ANTERIOR CEREBRAL,

Arises from the carotid, about a quarter of an inch before its termination, and pursues a very tortuous course, first passing forwards and inwards, on the under surface of the anterior lobe of the brain, between the olfactory and optic nerves, to both of which it distributes some minute twigs; on reaching the anterior extremity of the corpus callosum, the arteries of opposite sides approximate very closely, and are connected by the anterior communicating branch, and then turn upwards round the genu of the corpus callosum and between the two anterior lobes of the brain; bending now backwards on its superficial surface, but concealed by the hemisphere which overlaps them, they reach the posterior extremity of the corpus callosum, and turn downwards, to anastomose with the posterior cerebral from the basilar.

Collateral Branches.—Anterior communicating, and hemispheric,

1. Anterior Communicating.—Short, but thick, and remarkable for having the ganglion of Ribes resting on it; it forms the link of union between the two anterior cerebral arteries, just before they wind around the genu of the corpus callosum, and in many instances they are two, or sometimes three, in number.

2. Hemispheric, consist of several branches, which are given off as the trunk lies on the upper surface of the corpus callosum; the anterior passes upwards and backwards, and the posterior upwards and forwards, along the inner side of the hemispheres, supplying the gyrus fornicatus as they ascend, and, on reaching the upper surface of the brain, break up into numerous branches, which are distributed to the convolutions, anastomosing with filaments from the middle and posterior cerebrals.

Remarks.—The anterior cerebral arteries may join together at the point of the corpus callosum, without the existence of any communicating branch, and after continuing united for about half an inch, may again separate, to form the callosal arteries.

Anomalies.—We have witnessed an instance where the anterior cerebral was deficient on the left side, but that on the right was of undue magnitude, and bifurcated to form the terminal, or callosal branches.

III. MIDDLE CEREBRAL,

Is a very large branch, and must be considered as the true termination of the internal carotid; it winds upwards, backwards, and outwards, and, entering the fissure of Sylvius, divides into two branches—an anterior, which ramifies on the under surface of the corresponding lobe, and a posterior which bifurcates to enclose the lobule of the fissure (island of Reil); it then continues its course outwards, and winds round the external border of the hemisphere, to anastomose, on its upper surface, with the hemispheric arteries from the anterior cerebral.

Remarks.—This artery is peculiar, from the great number of capillaries which it gives off, and which sink into the sulci, for the supply of the structure of the brain.

Anomalies.—We are aware of none.

IV. POSTERIOR COMMUNICATING,

Arises from the back of the internal carotid, about a quarter of an inch below its termination; it passes backwards and inwards, and anastomoses with the posterior cerebral of the basilar.

Remarks.—This artery is occasionally very small, but its deficiency

in size is always compensated by the greater magnitude of that of the opposite side.

Anomalies.—It very often arises from the middle cerebral.

V. CHOROID ARTERY.

Uniformly present, arising from the back part of the carotid; it passes backwards, along the under surface of the crus cerebri, enters the anterior cornu of the great semilunar notch of Bichat, then reaches the inferior cornu of the lateral ventricle, and runs upwards between the tænia hippocampi and optic thalamus, accompanying the choroid plexus, to which it distributes numerous filaments; it now winds round the posterior extremity of the optic thalamus, and passes forwards and inwards, as far as the foramen commune anterius, where it anastomoses with perforating arteries from the circle of Willis, and the cerebellar twigs, which enter with the velum interpositum.

Remarks.—It is sometimes so small that it can with difficulty be demonstrated, and hence the statement that it is usually absent.

Anomalies.—It may arise, either as stated, or from the middle cerebral, or posterior communicating artery.

SUBCLAVIAN ARTERIES.

Those two trunks, which convey the blood partially to the head and neck, and altogether to the upper extremity, resemble the carotid arteries both in the differences of their size as well as in their mode of origin, the right being the larger, and arising from the arteria innominata, opposite the right sterno-clavicular articulation; the left smaller, and springing from the junction of the transverse with the descending portion of the arch of the aorta opposite the second dorsal vertebra, but both terminate at the same point, viz., the lower edge of the first rib; both are likewise divided into three stages by the anterior scalenus, which crosses them at a right angle, the first stage reaching from their origin to the internal edge of that muscle, the second, while they pass beneath it, and the third, from its external edge to the lower margin of the first rib, where they become axillary; their direction is at first upwards and outwards, till they ascend about half an inch above the clavicle, and then downwards, outwards, and a little backwards, till they ultimately terminate. We will confine our remarks, at present, to the right trunk.

Relations—First Stage.—Anteriorly, integument, platysma, fascia, sternal attachment of sterno-mastoid, deep cervical fascia, communicating branch from anterior to external jugular vein, sterno-hyoid

and thyroid, Burn's fascia, internal jugular, and vertebral veins, pneumogastric, and superior and middle cardiac nerves; posteriorly, longus colli, but at some distance from it, and separated from it by loose areolar tissue, recurrent laryngeal, and sympathetic nerves; internally, right carotid, and pneumogastric; and externally and inferiorly, lung and pleura.

Second Stage.—Anteriorly, integument, platysma, fascia, clavicular portion of sterno mastoid, deep cervical fascia, phrenic nerve, and anterior scalenus; posteriorly, cone of pleura, and middle scalenus.

Third Stage.—To arrive at this space, it passes through a triangular tendinous space, bounded in front by the anterior scalenus; behind, by the middle scalenus; and below, by the first rib, when it enters the posterior inferior triangle of the neck, where its relations are the following:—Anteriorly, integuments, platysma, external jugular vein, transversalis humeri artery, supraclavicular branches of cervical plexus, two layers of fascia, and a quantity of loose areolar tissue, with subclavian branch of brachial plexus; posteriorly, posterior scalenus and first rib; externally and superiorly, brachial plexus; and inferiorly and anteriorly, its own vein.

The left subclavian, in its first stage, is nearly vertical, and has anterior to it, the same parts as the right, with the addition of the formation of the left vena innominata, lung, pleura, cartilage of first rib, and clavicle; posterior to it, the longus colli, with which it is in immediate contact, and at its commencement, the thoracic duct, which is a little internal to it, with the sympathetic nerve; externally, the left lung and pleura; internally, œsophagus; and internally and anteriorly, left carotid, pneumogastric, and phrenic nerves. In its second stage, it is similar to the right, only that it is crossed by the thoracic duct, which winds over it, on the edge of the anterior scalenus, to join the subclavian vein.

Remarks.—The difference in length, between the two subclavian arteries is greater than what is generally supposed, and it has been found on accurate measurement, that the left is somewhat longer than the right and the arteria innominata taken together; the former is also much more deeply situated than the latter, the one at its origin being a little more than an inch from the surface and the other only half an inch. From the curved direction of these vessels, and the comparatively straight course of their corresponding veins, which always lie on a plain anterior and inferior to them, they may be very aptly compared to arcs of a circle, the arcs constituted by the arteries, to which the veins form the subtending chords. In their first stages, both vessels are surrounded by a nervous loop from the sympathetic (annulus of Vieussens).

Anomalies.—The right may arise separately from the arch, either

from the right or left extremity of the transverse portion, or even from the descending; or there may be a common trunk on the left side, from which it may spring in common with the left; where it arises from the left angle, the right usually passes to its own side, behind the œsophagus and trachea, or sometimes between these two tubes, as we had an opportunity of observing about eighteen years ago in an aged female subject; in that case, the vessel was of a more than ordinary size. Generally speaking, the left subclavian is very regular in its origin, but exceptions occasionally occur where it forms a common trunk with the right or left carotid, the latter being the more frequent arrangement.

Collateral Branches.—These are, in its first stage, the vertebral, internal mammary, and thyroid axis; and in its second, the superior intercostal, and cervicalis profunda; in its third, it normally gives off no branch.

I. VERTEBRAL ARTERY.

Arises from the upper and back part of the subclavian, and ascending backwards and upwards, enters the foramen in the transverse process of the sixth cervical vertebra, and runs through those of the others in succession, till it reaches the axis, where it suddenly curves upwards and outwards, to pass through the elongated transverse process of the atlas; on reaching the upper surface of that bone, it bends backwards and inwards, on its posterior half arch, to gain the triangular space on the back of the neck, and here again changing its direction, it runs upwards, forwards and inwards, perforating the posterior occipito-atlantoid ligament and dura mater, when having entered the cranial cavity, it gradually approximates to its fellow of the opposite side, with which it at last unites, at the lower part of the pons Varolii, to form the *basilar* trunk.

Relations.—Immediately after its origin, it lies in a triangular space, which is bounded internally by the longus colli, and pneumogastric nerve; externally, by the anterior scalenus, and phrenic: inferiorly, by its own parent trunk; anteriorly, by the internal jugular vein, and inferior thyroid artery; posteriorly, by the transverse process of the seventh cervical vertebra, and a lymphatic gland; and internally and anteriorly, by the inferior cervical ganglion of the sympathetic. As it continues its course upwards, through the several foramina in the transverse processes, it has, anterior and posterior to it, the intertransversales muscles; and while the cervical nerves emerge behind it, it is invested by a plexus from them and from the inferior ganglion of the sympathetic, while a vein, or sometimes two veins accompany it in its course; as it bends backwards and inwards, it

runs between the superior oblique and posterior occipito-atlantoid ligament, below the occipital bone, and above the posterior half-arch of the atlas, which it deeply grooves, and from which it is separated by the ganglion of the suboccipital nerve, which lies inferior and internal to it. On the upper and back part of the neck, it occupies a triangular space, bounded above, by the superior oblique; below, by the inferior; behind, by the rectus capitis posticus major; here it is covered by the great occipital nerve, a quantity of areolar tissue, and dense fascia, with the complexus, and trapezius muscles. After perforating the posterior occipito-atlantoid ligament, and dura mater, it runs between the first and second teeth of the ligamentum denticulatum, the former of which separates it from the lingual, and spinal accessory nerves, while it occasionally passes between the origins of the lingual, and is at this point closely applied to the side of the medulla oblongata.

Remarks.—This artery may occasionally run upwards along the neck, and enter the foramina of any of the transverse processes of the cervical vertebræ from the second to the sixth, but, we believe, never the seventh; in its course through them, it is always more or less tortuous. On the left side, the vessel is also crossed by the thoracic duct.

Anomalies.—The right, is generally normal in its origin, but the left often arises from the arch of the aorta, or occasionally may spring from the carotid. Great disparity has been observed, in the size of the vessels of opposite sides.

Collateral Branches.—Some few small twigs thrown off in the neck, which enter the spinal canal to communicate with the arteries of that region, it also occasionally gives off the posterior meningeal, with anastomotic twigs to the occipital, and cervicalis profunda. Its normal branches are, the anterior and posterior spinal, and inferior cerebellar.

1. Anterior Spinal.—This branch arises from the vertebral, immediately before its termination in the basilar; and, passes downwards and inwards, uniting with its fellow of the opposite side, and circumscribing a lozenge-shaped space, on the front of the medulla oblongata. The compound trunk thus formed, continues its course downwards, in the anterior median furrow of the cord, beneath the thickened process of pia mater (membrana resplendens), and terminates inferiorly, at the coccyx, by anastomosing with branches of the middle and lateral sacral. In its descent it communicates with the deep cervical, vertebral, intercostal and lumbar.

Remarks.—It is very tortuous, presenting several dilatations and constrictions and is nearly as large at its termination as at its commencement, owing to the numerous anastomotic branches which it

receives as it descends. Thus, it communicates with the cervicalis profunda, and vertebra, in the neck; with the intercostals in the thorax; with the lumbar in the abdomen; and with the sacral in the pelvic region.

Anomalies.—It may sometimes arise as a single trunk from the basilar.

2. Posterior Spinal.—Springs from the back part of the vertebral, a little below the last, and having sent up a small filament to supply the fourth ventricle, divides into two branches,—an interual, which descends along the margin of the posterior median furrow; and an external, which runs on the outer side of the posterior spinal nerves, anastomosing with each other frequently, and with the anterior spinal, as well as its fellow of the opposite side. They also communicate with the same arteries as the anterior spinal.

Remarks.—These branches also are tortuous, and rarely of the same size on both sides.

Anomalies.—They frequently arise, at least one of them, from the inferior cerebellar.

3. Inferior Cerebellar.—Generally large, arising from the vertebral just before its termination; it passes backwards and inwards, round the medulla oblongata, first between the filaments of origiu of the ninth nerve, and then between the pneumogastric and spinal accessory. It now enters the posterior median fissure of the cerebellum, (valley of Haller), where it lies very close to that of the opposite side, and divides into two branches,—an internal, which continues its course to the upper surface of the cerebellum as far as the superior vermiform appendix, where it anastomoses with the superior cerebellar, and from this anastomosis branches pass inwards, in the layers of the velum interpositum, as far as the foramen commune anterius, to communicate with the choroid, and perforating filaments from the circle of Willis; and an external, which winding round the outside of the cerebellum near its upper margin, unites with corresponding branches of the superior cerebellar.

Remarks.—It might be almost stated as a rule, that the arteries of opposite sides are always different in size, and sometimes one is found to be so small that after supplying the medulla it becomes altogether lost, when the other, which is commensurately larger, will be found to divide in the posterior cerebellar furrow iuto two for the usual distribution.

Anomalies.—One or both often arise from the basilar.

BASILAR ARTERY.

Formed by the junction of the vertebrals at the lower margin of

the pons, extends upwards and forwards, to terminate at the anterior border of the pons Varolii.

Relations.—Inferiorly, basilar process of occipital bone and dura mater; superiorly, pons Varolii; and on either side, arachnoid canals, with sixth pair of nerves.

Remarks.—These are reserved, to be included in observations on the cerebral circulation.

Anomalies.—We are aware of none, except that it may occasionally be deflected to one side.

Collateral Branches.—Besides a number of capillary twigs to the pons, it also gives off the superior cerebellar, and the posterior cerebral, of each side.

1. Superior Cerebellar, are two large branches which, one on each side, arise from the basilar, a quarter of an inch previous to its termination; each passes at first upwards and outwards, between the crus cerebri and pons, then over the pons, and behind the third nerve, then beneath the fourth nerve, and the tentorium cerebelli, when it divides into two branches,—an external, which turns outwards on the upper surface of the cerebellum to its free margin, where it anastomoses with the external division of the inferior cerebellar; and an internal, which passes inwards, to the superior vermiform process, to communicate with the internal branch of the inferior cerebellar. A small twig, the auricular, is usually given off from the superior cerebellar, which, lying in a groove in the portio mollis, and beneath the portio dura, enters the auditory meatus, for the supply of the cochlea, and vestibule.

2. Posterior Cerebral are likewise large; and arise from the termination of the basilar, and in front of the third nerve; each then winds upwards and outwards, round the crus cerebri of its own side, and above the tentorium, dividing into two branches,—an internal, to anastomose with the callosal at the posterior extremity of the corpus callosum; and an external, to communicate with the cerebral, and with the hemispheric branches of the anterior cerebral.

Remarks.—The divergence of these last described branches forms a part of a remarkable arterial anastomosis at the base of the brain, known as *the circle of Willis*, which should rather have been termed the *heptagon*, as it possesses seven distinct walls. Thus, it is bounded posteriorly, by the basilar trunk and posterior cerebral; laterally, by the posterior communicating and internal carotids; and anteriorly, by the anterior communicating, and anterior cerebral.

Anomalies.—None, except a discrepancy in size, sometimes very remarkable.

General Remarks on the Cerebral Circulation.—The difference in the mode of supply to this organ, as contrasted with that to the

other component tissues of the body, may be thus briefly enumerated :—1. The great size of the vessels, when considered relatively to the positively small amount of matter to which they are distributed ; 2. Their long and tortuous course, and transit through unyielding bony canals ; 3. The marked weakness of their walls, when within the cranial cavity ; 4. The convergence of two primary branches, in order to constitute a trunk of diminished calibre ; 5. Their frequent and free inosculations ; and 6. Their peculiar mode of distribution to the neural masses.

The strongest proof of the vital importance of the brain substance may be deduced from considering the vast amount of nutrition which it receives ; and pathology clearly shows, that this quantity is absolutely necessary, both to the proper development of its functions, and to its integrity as a component part of the entire animal system. But while nature has been thus careful, in bestowing on it this apparent excess of nutrition, she has been equally anxious to modify any injurious effects that might accrue from it, by deriving the stream from a remote source, by causing the current to ascend against gravity, and by including the containing tubes within osseous girdles, so that they are in a great measure constrained to transmit nearly the same amount of blood, at all times ; to this may be added, also, their numerous curves, a means admirably calculated to diminish the impetuosity of the vital fluid, by increasing friction. The convergence of the two vertebral arteries, for the formation of the basilar, would on a cursory view, appear to imply a desire to increase, not to diminish, the force and rapidity of the circulation, but the obvious explanation of this arrangement, may be thus simply stated—that inasmuch as the entire weight of the brain is thrown upon this particular vessel, it is clear that unless some peculiar mechanism was employed, the blood would be incapable of overcoming the resistance thus entailed on it by compression, and more especially as the arterial tubes of this region are deficient in that elasticity which is their predominant characteristic in other situations, both the external and middle coats being absolutely thinner and weaker, and in many instances altogether incapable of demonstration. The most remarkable inosculation that exists is that of the circle of Willis, all danger from undue pressure being here guarded against, by the subarachnoid fluid, an unresisting medium in which the vessels are continually bathed. The pia mater forms the great vehicle for conducting the arterial ramifications for the nutrition of the organ ; but it must be observed, that several large branches permeate the white substance, for the more complete supply of the grey structure.

II. THYROID AXIS.

Arises from the anterior and superior part of the subclavian, a little external to the vertebral; it passes upwards and outwards, for about half an inch, and then terminates by dividing into its four ultimate branches.

Relations.—Anteriorly, integument, platysma, fascia, sterno-mastoid, deep cervical fascia, and internal jugular vein; and posteriorly, edge of scalenus, and the phrenic nerve.

Remarks.—We have observed nothing very peculiar concerning this artery, except its variable length.

Anomalies.—It may arise from the subclavian, in its second stage, or in common with the internal mammary, or it may have no existence at all, each of its branches arising independently from the subclavian.

Collateral Branches.—Inferior thyroid, ascending cervical, transversalis colli, and transversalis humeri.

1. Inferior Thyroid arises from the inner side of the thyroid axis; passes upwards and inwards, towards the thyroid body, and divides into three branches, of which the most external anastomoses with the superior thyroid, the middle enters the gland for its supply, while the internal follows the isthmus or connecting lobe, and communicates with its fellow of the opposite side.

Relations.—Anteriorly, sheath of the vessels, inferior laryngeal, and sympathetic nerve; and posteriorly, longus colli, and vertebral artery.

Remarks.—This artery is very variable in its size, which appears to be regulated by that of the superior thyroid. It also constantly gives off a small branch (inferior laryngeal), which accompanies the inferior laryngeal nerve, for the supply of the muscles of the larynx.

Anomalies.—It may arise either from the vertebral, common carotid, or subclavian, and is sometimes found double. In an instance where the right subclavian arose from the descending portion of the arch of the aorta, and ran to its destination in front of the trachea, the inferior thyroid ascended directly in front of that tube, although its origin was normal from the thyroid axis.

2. Ascending Cervical.—Arises from the upper extremity of the thyroid axis, and passing directly upwards, anastomoses with the vertebral, and occipital.

Relations.—Anteriorly, deep cervical fascia, and sterno-mastoid; posteriorly, anterior scalenus; externally, phrenic nerve; and internally, internal jugular vein.

Remarks.—We have never observed it absent, though occasionally it is very small.

Anomalies.—It very often springs from the inferior thyroid, but it may arise from the transversalis colli or humeri, or from the subclavian itself. In some instances it is remarkably large, and under those circumstances the occipital artery may terminate at the rectus capitis lateralis, when the ascending cervical will take its place from this point, and supply the branches of its third stage.

3. TRANSVERSALIS COLLI, OR POSTERIOR SCAPULAR.—Usually a large branch, arising from the posterior wall of the thyroid axis; it passes at first backwards and upwards, till it arrives on a level with the superior angle of the scapula, parallel to the posterior border of which it bends downwards, here receiving the name of posterior scapular, and at its inferior angle anastomoses with the subscapular, and circumflexus scapulæ.

Relations.—Anteriorly, sterno-mastoid, omo-hyoid, trapezius, levator anguli scapulæ, rhomboidei minor and major; posteriorly, anterior scalenus, phrenic nerve, brachial plexus, middle and posterior scaleni, splenius colli, and serratus posticus superior.

Remarks.—It will be recollected, that this artery is found in the two posterior triangles of the neck, viz., in the apex of the lower, and base of the upper, in both situations being comparatively superficial, as it is covered only by the skin and fascia; and in its descent along the base of the scapula, is often found buried in the insertions of the serratus magnus. At its termination it occupies the triangular interval, bounded by the trapezius above, the latissimus dorsi below, and posterior border of the scapula externally.

Anomalies.—It may arise by a common trunk with the transversalis humeri, or from the subclavian in its first, second, or third stage.

COLLATERAL BRANCHES.—Two in number,—superficial, cervical, and spinal.

1. SUPERFICIAL CERVICAL, arises from the angle of the transversalis colli, as it bends downwards, beneath the levator anguli scapulæ; it ascends beneath the trapezius, supplying it, as also the glands and areolar tissue, and anastomoses with the vertebral, and the occipital.

2. SPINAL.—Generally a large branch, arising from the artery while it lies at the base of the scapula; it passes inwards, supplying the erectors of the spine, and communicates with the posterior intercostals.

4. TRANSVERSALIS HUMERI, *or Suprascapular*, also arises from the back part of the thyroid axis; it passes downwards and backwards, to the superior costa of the scapula, and entering the supraspinous fossa above the transverse ligament, and through the fibres of the omohyoid muscle, divides into two branches,—the superior, supplying the supraspinatus, while the inferior winding downwards, between the spine of

the scapula and edge of the glenoid cavity, and under the spino-glenoid ligament, supplies the infraspinatus muscle, and anastomoses with the circumflexus scapulæ.

Relations.—Anteriorly, sterno-mastoid, fascia, external jugular vein, clavicle, trapezius, and omo-hyoid; posteriorly, the scaleni, phrenic nerve, and brachial plexus, with the subclavian artery in its third stage.

Remarks.—This vessel crosses the subclavian artery in its second stage, but is separated from it by the anterior scalenus, and phrenic nerve; it nearly at the same point, is crossed superficially by the external jugular vein, but divided from it by the cervical fascia. While lying in the posterior inferior triangle of the neck, it is generally concealed from view by the clavicle, to which, as well as to the subclavian vein, it is attached by a process of the deep fascia, and hence the idea entertained of its frequent absence, as it is kept firmly fixed beneath the bone, concealed from view, unless the investing fascia is divided.

Anomalies.—It may arise in common with the transversalis humeri from the subclavian, in either of its three stages; and we have also observed it to spring from the axillary.

Collateral Branches.—Only one, the

1. Supra-acromial, which is given off from the artery while under the trapezius; it passes outwards, beneath that muscle, to the acromion process, and there anastomoses with the acromial-thoracic, and circumflex, from the axillary.

III. INTERNAL MAMMARY,

Arises from the inferior part of the subclavian, runs downwards and inwards, along the outer margin of the sternum, enters the wall of the abdomen through the costo-xiphoid space, which is bounded on either side by the first costal and xiphoid attachments of the diaphragm, and in front by the costo-xiphoid ligament, insinuates itself into the back part of the sheath of the rectus; and, having descended as low as the umbilicus, anastomoses with both epigastrics, and the lumbar arteries.

Relations.—Anteriorly, phrenic nerve, clavicle, left vena innominata, costal cartilages, intercostal muscles, costo-xiphoid ligament, and rectus muscle; posteriorly, triangularis sterni, pleura, peritonæum, and posterior layer of internal oblique.

Remarks.—The position of the phrenic nerve to this vessel is not always constant, as we have observed it not only splitting, but likewise running behind it. It its course downwards, it lies not quite a quarter of an inch from the edge of the sternum.

Anomalies.—It may arise in common with the thyroid axis, or from the second or third stages of the subclavian, from the innominata, or even from the arch of the aorta. Its relation to the triangularis sterni is always very variable, as it may either run in front of it, or behind it, or through it.

COLLATERAL BRANCHES.—Thymic, mediastinal, comes nervi phrenici, intercostals, diaphragmatic, and ramus abdominalis.

1. THYMIC.—Small twigs, sometimes only one, that arise from the artery as it enters the thorax; they pass inwards, and supply the thymus gland, and loose areolar tissue, communicating with those of the opposite side.

2. MEDIASTINAL.—Small twigs that ramify on the posterior surface of the sternum, to which bone they also send several filaments.

3. COMES NERVI PHRENICI.—Arises opposite the first rib; it passes down, in company with the phrenic nerve, on the side of the pericardium, to which it sends several twigs, and reaching the diaphragm, divides into two branches, which, encircling the cordiform tendon, form a zone around it, from which filaments are distributed to the muscular structure.

4. INTERCOSTALS.—Generally five in number; they arise from the outer wall of the artery, opposite the five superior intercostal spaces, and passing outwards, at first between the pleura and internal layer of intercostal muscles, perforating the latter, and lying between the external and internal, they run outwards, each along the inferior margin of the corresponding superior rib, usually sending downwards a smaller branch, which winds along the upper edge of the inferior rib; they terminate by anastomosing with similar branches from the superior intercostal, and thoracic aorta. From these, and sometimes from the internal mammary itself, branches are thrown off, to supply the integuments of the thorax, and the two pectoral muscles.

5. RAMUS ABDOMINALIS, descends, in the back part of the sheath of the rectus, to anastomose with the superficial and deep epigastrics.

6. DIAPHRAGMATIC.—Arises opposite the xiphoid cartilage, and passes downwards, and outwards, behind the cartilages of the false ribs, supplying the diaphragm, and sending small branches into the lower intercostal spaces, to anastomose with the aortic intercostals.

The branches given off in the second stage of the subclavian, are the superior intercostal, and the cervicalis profunda.

IV. SUPERIOR INTERCOSTAL

Arises from the back part of the subclavian, while under cover of the anterior scalenus; it passes downwards and backwards, and

terminates on the right side, at the third intercostal space; and on the left, at the second.

Relations.—Anteriorly, pleura ; posteriorly, neck of ribs, and first dorsal nerve ; internally, dorsal ganglia of sympathetic ; and externally, emergence of proper spinal nerves.

Remarks.—We have occasionally observed this vessel passing behind the neck of the first rib, and then coming forwards, between it and the second, to assume its proper position.

Anomalies.—It may arise from the first stage of the sub-clavian, or from the vertebral, thyroid axis, or deep cervical.

COLLATERAL BRANCHES.—Anterior, and posterior.

1. ANTERIOR, or INTERCOSTAL, consist of two on the left and three on the right side; they pass directly outwards on the anterior costo-transverse ligament, then on the external layer of intercostals, and enter between the latter and internal, at the angle of the rib; a little beyond this point they each throw off a small branch, which runs along the margin of the rib below, supplying the muscles in front of it and behind it, while the superior wind beneath the inferior edge of the rib above, but separated from it by the vein, and terminates by anastomosing with the mammary and branches from the axillary.

2. POSTERIOR BRANCHES, pass backwards between the transverse processes, above and below; the bodies of the vertebræ internally, and the costo-transverse ligament externally, and piercing the erectors of the spine, which they supply, terminate in cutaneous filaments, which ramify in the integument over those muscles, anastomosing freely with each other.

V. DEEP CERVICAL,

Arises close to the superior intercostal, and passes at first backwards, between the first rib and transverse process of the seventh cervical vertebra, then upwards and backwards, and terminates by anastomosing with the vertebral, and the occipital.

Relations.—Anteriorly, anterior scalenus, brachial plexus and complexus ; posteriorly, middle and posterior scaleni, and semispinalis colli.

Remarks.—We have observed it to pass between the sixth and seventh transverse processes. While lying between the semispinalis colli, and complexus, it is in company with the posterior cervical plexus, and posterior jugular vein, and is always bound to the subjacent muscle by a dense fascia; in passing backwards, it runs between the last cervical and first dorsal nerves.

Anomalies.—It may arise from the subclavian, transversalis colli, or superior intercostal.

ARTERIES OF THE UPPER EXTREMITY.

As we have already remarked, the subclavian artery terminates at the lower border of the first rib; or to speak more properly, it changes its name, at this point, from subclavian to axillary, for the trunk is still the same, presenting no single feature by which we would be enabled to distinguish one part from the other. The division is in fact purely arbitrary, depending upon the space which each occupies for the nomenclature which they have severally received.

AXILLARY ARTERY.

Commences opposite the inferior margin of the first rib, and passing downwards, backwards, and outwards, terminates in the brachial, at the lower margin of the latissimus dorsi, and teres major. It is crossed above its middle by the pectoralis minor, and hence its division into three stages,—the first, extending from the first rib to the upper margin of the lesser pectoral; the second, comprehending that portion which lies beneath the lesser pectoral; and the third, reaching from the lower border of that muscle to that of the latissimus dorsi, and teres major.

Relations—First Stage.—Anteriorly, integument, platysma, fascia, supraclavicular branches of cervical plexus, great pectoral, costo-coraco-clavicular ligament, anterior thoracic nerve, and cephalic vein; posteriorly, first indigitation of serratus magnus, and first layer of intercostal muscles, with middle thoracic nerve; externally and posteriorly, brachial plexus; and internally and anteriorly, axillary vein.

Second Stage.—Anteriorly, integument, fascia, greater and lesser pectorals; posteriorly, brachial plexus, areolar tissue, and lymphatic glands; externally and anteriorly, coracoid process; and internally and slightly anteriorly, the axillary vein.

Third Stage.—Anteriorly, integument, fascia, and great pectoral, axillary vein, and trunk of median nerve; posteriorly, tendons of subscapular, latissimus dorsi, and teres major, with circumflex, and musculo-spiral nerves; externally, external cutaneous nerve, and outer head of the median; and internally, internal cutaneous, ulnar, and inner head of the median. In this stage, it is also slightly overlapped by the inner edge of the coraco-brachialis.

Remarks.—The axillary artery, is of much importance, in a surgical point of view. Between the side of the thorax and the humerus, it occupies a space called the *axilla,* which varies in extent, according to the height to which the arm may be elevated. The interior of the cavity, when cleared of its contents, represents a cone with

three sides, the apex corresponding to a triangular bony space superiorly, bounded in front by the clavicle; behind and internally, by the first rib; and externally, by the superior costa of the scapula; through this space, which is bridged across by the deep cervical fascia, the following parts pass, each carrying on it a tubule of the fascia, as they either ascend or descend—most internally, the axillary vein, external to which is the artery, surrounded by a series of lymphatic ducts, and still more externally, the brachial plexus, which also lies on a plane posterior to both artery and vein. The base of this region is formed by the latissimus dorsi, teres major, and great pectoral, the interspace between the two first and the last of these muscles being completed by integument, fascia, and a few tendinous bands stretched between their opposite margins, through which the branches of the intercosto-humeral nerves ramify, in their course to reach the back and inner side of the arm. The boundaries of *the axillary space* may be thus stated:—Anteriorly, both pectorals, and ligamentum bicorne, the lesser pectoral however, only forming a partial covering, being deficient both above and below; internally, ribs, intercostal muscles, and serratus magnus; and posteriorly and externally, subscapular, teres major, and latissimus dorsi. In its natural condition, it is filled up by a quantity of lax watery areolar tissue, numerous glands, axillary artery and vein, with their branches, brachial plexus, and intercosto-humeral nerves. The axillary glands are divisible into four sets, which observe the following arrangement:—Those constituting the first set, are irregularly scattered through the cavity; those of the second, are found on its posterior wall, in company with the subscapular artery; those of the third, on its anterior, with the thoracica longa; and those of the fourth, pass upwards, with the axillary trunk itself, and become continuous with those of the neck. The base communicates with the brachial region, through an aperture, close to the humerus, bounded in front, by the insertion of the great pectoral; behind, by the conjoined tendons of the latissimus dorsi and teres major; externally, by the bone; and internally, by the fascia, constituting the floor of the cavity, and prolonged on the inner aspect of the arm; through this, pass the coraco-brachialis, both tendons of the biceps, and axillary artery, with its vein directly in front of it, and with the ultimate branches of the plexus, investing it on all sides.

Anomalies.—The axillary may divide into radial, and ulnar, in this space, as high up as the inferior margin of the first rib, of which we formerly saw an example; or in its centre, or lower part. It may also bifurcate into two, one of which will throw off all the axillary, and sometimes the brachial branches, while the other descends to divide into radial, and ulnar. We have also seen

an instance, where at the upper part of the space it divided into two branches of nearly equal size, but which united again at the lower part, the median nerve passing from behind forwards, between them.

COLLATERAL BRANCHES of the AXILLARY, are seven in number, and may be divided into four internal, viz., thoracica acromialis, thoracica suprema, thoracica alaris, and thoracica longa; and three external, viz., anterior, and posterior circumflex, and subscapular.

I. THORACICA ACROMIALIS.

A thick, short trunk, varying from a quarter to half an inch in length, arises from the front of the axillary, opposite the acromion process, and is thus bounded :—Externally and superiorly, by the cephalic vein, as it curves around it, to join the axillary vein; internally, by the axillary vein; and below, by the lesser pectoral. Between the deltoid and greater pectoral, it divides into four branches,—one of which passes upwards and outwards, beneath the deltoid muscle, and along the margin of the triangular ligament, to the acromion process, where it anastomoses with the circumflex, and transversalis humeri; a second (thoracica humeraria), winds downwards and outwards, between the deltoid and great pectoral, in company with, but beneath, the cephalic vein, enters the substance of the deltoid, and communicates with the circumflex; the third, runs downwards and inwards, along the upper border of the lesser pectoral, to the serratus magnus, which it supplies, anastomosing with the mammary and intercostals; while the fourth, always very small, is reflected upwards and inwards, over the ligamentum bicorne, which it afterwards perforates, for the supply of the subclavius muscle.

II. THORACICA SUPREMA.

Smaller than the last; it runs downwards and inwards, between the two pectorals, to both of which it gives numerous branches, and ultimately anastomoses, on the wall of the thorax, with the mammary and intercostals.

III. THORACICÆ ALARES.

Usually numerous, but small; they spring from the inner side of the axillary, beneath the lesser pectoral, and are distributed to the glands and areolar tissue of the axillary cavity, communicating freely with each other.

IV. THORACICA LONGA, OF EXTERNAL MAMMARY,

Arises below the tendon of the lesser pectoral, and passing downwards and inwards, terminates on the side of the thorax, by anastomosing with the mammary and intercostal.

Relations.—Anteriorly, greater pectoral; posteriorly, serratus magnus; and superiorly, lesser pectoral.

Remarks.—These four thoracic branches are very variable in size, particularly the alar and long thoracic, the latter being the larger in the female, from supplying the mammary gland.

Anomalies, are more frequent in these branches than in any others in the body; in fact they are very rarely regular. The two first almost always arise in common, or the entire of them may spring from a common trunk, while the alar thoracic may be either single, and then subdivide; or consist of two, three, or four primary branches.

V. ANTERIOR CIRCUMFLEX.

Always small, as contrasted with the posterior; it arises from the axillary, opposite the lower edge of the subscapular tendon, and passes directly outwards, as far as the bicipital groove, where it divides into three branches—an ascending, which enters the joint with the long tendon of the biceps, for its supply; a descending, which passes downwards, through the groove, to anastomose with the profunda; and a middle, which continues its course, to communicate with the posterior circumflex.

Relations.—Anteriorly, deltoid, external cutaneous nerve, outer head of median, coraco-brachialis, and short and long heads of biceps; posteriorly, surgical neck of humerus.

Anomalies.—It may arise in common with the posterior circumflex, or from the long thoracic, or the subscapular.

VI. POSTERIOR CIRCUMFLEX.

Always large; arises close to the preceding, and runs backwards and outwards, through a quadrilateral space, behind the joint, and divides into three sets of branches—scapular, to anastomose with the suprascapular; articular, to supply the joint; and muscular, to the deltoid, anastomosing with the anterior circumflex.

Relations.—As it winds backwards, it has above it, the capsular ligament, and circumflex nerve; below it, the teres major, and latissimus dorsi; external to it, the neck of the humerus; and internal to it, the long head of the triceps.

Anomalies.—It frequently springs from the subscapular, anterior

circumflex, or long thoracic; occasionally, from the superior profunda, when, in its course to reach its destination, its direction is peculiar, as it no longer passes through the quadrilateral space just described, but through another, below the axillary cavity, triangular in shape, and bounded as follows:—Above, teres major, and latissimus dorsi; externally, shaft of humerus; and internally, long head of triceps.

VII. SUBSCAPULAR.

The largest branch of the axillary; arising opposite the lower margin of the subscapularis tendon; it passes downwards, backwards, and inwards, for about an inch, and then divides into two branches—an anterior or proper subscapular, and a posterior or circumflexus, or dorsalis scapulæ.

Relations.—Anteriorly, internal cutaneous, ulnar, and musculo-spiral nerves, with the subscapular, and the axillary vein; posteriorly, tendon of subscapular.

1. Anterior, or Continued Trunk.—Passes downwards and backwards, along the inferior margin of the subscapular muscle, and reaches the inferior angle of the scapula, where it anastomoses with the posterior scapular, and dorsalis scapulæ.

2. Circumflexa, or Dorsalis Scapulæ.—In size the proper continuation of the subscapular trunk; it passes backwards, through a triangular space, bounded externally, by the long head of the triceps; above, by the teres minor; and below, by the teres major, and latissimus dorsi; winding now upwards, into the infraspinous fossa, and lying close to the bone, it divides into two branches—an anterior, to anastomose, beneath the spine, with the infraspinous of the suprascapular; and a posterior, which descends to communicate with the posterior scapular, and continued trunk of the subscapular.

Remarks.—The point of division of the subscapular, into the two terminal branches just described, is very variable, ranging from a quarter of an inch to an inch and a half from its point of origin; and although we have followed the general rule in making the posterior, or circumflex scapulæ, pass through the triangular interval, of which we have given the boundaries in the preceding paragraph, still our experience would lead us to state, that such is rarely if ever its true course, as the vessel almost invariably runs backwards, above the teres minor, and close to the inferior costa of the scapula, to which it is united by a dense fibrous arch, which protects it from the muscular pressure, to which it would otherwise be so liable.

Anomalies.—The subscapular may arise from the posterior circumflex, or occasionally from the long thoracic.

ARTERIES OF ARM.

As in the preceding instance, here again there is no direct division between the axillary artery, and the brachial, the trunks being precisely the same, and the nomenclatnre purely regional.

BRACHIAL ARTERY.

The direct continuation of the axillary, commences at the inferior margin of the latissimus dorsi, and teres major, from which it passes downwards, forwards, and outwards, and terminates a little above the coronoid process of the ulna, by dividing into radial, and ulnar.

Relations.—Anteriorly, inner margin of biceps, median nerve, and semilunar fascia, which separates it from the median basilic vein, and internal cutaneous nerve, in the triangular hollow at the bend of the elbow ; posteriorly, long head of triceps, but separated from it by the musculo-spiral nerve, and superior profnnda artery, short head of the triceps, insertion of the coraco-brachialis, and brachialis anticus; internally, brachial aponenrosis, internal cutaneous, and, lower down, median nerve, with basilic vein ; and externally, coraco-brachialis, and median nerve above; and tendon of biceps inferiorly.

Remarks.—It will be observed that the median nerve holds three relations to the brachial artery, being at first slightly to its onter side, but, crossing it anteriorly, about the middle of the arm, becomes ultimately internal to it. Two veins likewise accompany this artery ; one, the larger, lying internal and posterior to it; the other, smaller, external and anterior; while numerous cross branches unite them to each other. Dr. Corbett, in his work on the Artcries, has drawn a very fair analogy between this artery, with its muscular and fascial relations, and the femoral, as it occupies the middle third of the thigh, or Hunter's canal. Opposite the flexure of the joint, the brachial artery lies in a triangular space, called the anticnbital fossa, which may be exposed by removing the integument, and superficial fascia, with the external and internal cutaneons nerves, basilic, cephalic, and median basilic, and median cephalic veins, and ultimately the semilunar fascia of the biceps, which constitutes its operculum or covering. This space is bounded externally, by the supinator longus; internally, by the pronator teres; superiorly, by the belly of the brachialis anticus ; posteriorly, by the tendon of the brachialis anticus, with that of the biceps; and anteriorly, by the semilunar aponeurosis. It contains three very important parts, which lie, from without inwards, in the following order :—tendon of biceps, brachial artery, and median nerve ; but it should be remembered, that still more externally, between the supinator longus and brachialis anticus, the mus-

culo-spiral nerve and artery are situated ; and more internally, beneath the pronator teres, is the anostomotica magna, communicating with the anterior ulnar recurrent, while in the apex of the space are found the mediana profunda vein, radial and ulnar arteries, with interosseous trunk.

Anomalies.—The brachial artery may sometimes be double, depending on a high bifurcation of the axillary, and in this case its representative branch is generally that which afterwards becomes the radial, which takes its usual course, while that which is to be the ulnar, runs more directly towards the internal condyle. Exceptions to this rule will however, occur, and then the smaller trunk or radial, which at first lay internal to the larger, as far as the inferior third of the arm, will cross under, and become external to it, the larger, or ulnar, in this instance representing the brachial trunk; where this high bifurcation does exist, the two branches usually communicate, by a cross branch, at the bend of the elbow. The brachial may also separate into its two divisions, at some distance, either above or below, the coronoid process; and it should likewise be borne in mind that the median nerve often crosses behind, and not in front of, the artery.

Collateral Branches of the Brachial.—Several to the muscles clothing the humerus, and one usually very large, the nutritious artery of the bone ; those which have received names are—1. The superior profunda; 2. Inferior profunda; and 3. Anastomotica magna.

I. SUPERIOR PROFUNDA.

The largest branch ; arising from the brachial, immediately below the tendons of the latissimus dorsi, and teres major ; it passes backwards and outwards, in company with the musculo-spiral nerve, between the short and long head of the triceps, and then between that muscle and the bone, where it divides into two branches—a musculo-spiral or anterior, and an olecranoid or posterior ; the former winds round the humerus, which it grooves, and a little below the middle of that bone divides into two branches, one of which perforates the external intermuscular septum, and reaching the cleft between the supinator longus and brachialis anticus, anastomoses with the anterior radial recurrent ; while the other descends, behind the external condyle, to communicate with the posterior interosseous recurrent ; the posterior or olecranoid branch passes almost vertically downwards, lying in the substance of the triceps, to the same point, where its anastomosis is similar.

Anomalies.—It may arise in common with the posferior circum-

flex, the trunk of origin being in this instance from the brachial, or it may spring from a branch common to it and the inferior profunda.

II. INFERIOR PROFUNDA.

Smaller than the last; arises from the brachial, opposite the insertion of the coraco-brachialis; it passes at first downwards and backwards, on the brachialis anticus, and between the ulnar nerve and brachial artery; along with that nerve perforates the internal intermuscular septum, then a few fibres of the triceps, and reaching the groove between the internal condyle and olecranon process, between the two heads of the flexor carpi ulnaris, anastomoses with the posterior ulnar recurrent.

Anomalies.—It generally arises in common with the nutritious artery of the bone, or sometimes with the superior profunda.

III. ANASTOMOTICA MAGNA.

Variable in size; arises about an inch and a half above the internal condyle; it passes directly inwards, under the median nerve, and on the brachialis anticus; and on reaching the inner edge of that muscle divides into two branches—a descending, and a transverse; the former passes downwards, under the pronator teres, and on the brachialis anticus, to anastomose with the anterior ulnar recurrent; while the latter, piercing the internal intermuscular septum, communicates with the inferior profunda.

Anomalies.—It may arise from the brachial by two distinct trunks, each of which will then pursue the course indicated above.

ARTERIES OF THE FOREARM.

At the bend of the elbow, or opposite the coronoid process of the ulna, the brachial artery divides into two branches—the radial, and the ulnar.

RADIAL ARTERY.

Must be considered as the direct continuation of the brachial in direction, though it is always inferior in size to the ulnar; it passes at first vertically downwards, as far as the upper edge of the annular ligament (first or vertical stage), then winds backwards, to the dorsum of the hand, and ultimately through the first interosseous space to its palmar aspect (oblique stage), where it divides into its ultimate branches.

Relations—First Stage.—Anteriorly, integument, fascia, twigs of

external cutaneous nerve, and intermuscular septum; posteriorly, tendon of biceps, supinator brevis, and branches of musculo-spiral nerve, tendon of pronator teres, radial attachment of flexor sublimis, tendon of flexor pollicis longus, and pronator quadratus; externally, supinator longus, and radial nerve, the latter, only for its upper two-thirds; and internally, pronator teres for its upper third, and flexor carpi radialis for its two inferior.

Second Stage.—Posteriorly, tendons of extensor ossis metacarpi, and primi internodii pollicis, and after crossing the triangular space intercepted between those tendons and that of the extensor secundi internodii pollicis, it ultimately rests on that of the abductor indicis; anteriorly, external lateral ligament, back of carpus, occasionally tendon of extensor carpi radialis longior, and adductor pollicis.

Remarks.—The radial nerve is in communication with its artery in only the upper and middle thirds of its vertical stage, in both being external to it, but more remote from it in the former; in its inferior third, it winds away from it altogether under the supinator longus, but we will see that it again gets into relation with it in its oblique stage on the back of the carpus, where the vessel lies in a perfect triangular space, bounded externally by the extensor ossis metacarpi and primi internodii pollicis; internally, by the extensor secundi internodii pollicis; superiorly, by the lower edge of tho posterior annular ligament, while the apex is formed by the convergence of the several tendons to their insertion into the thumb. Here the vessel is most superficial, being covered only by the integument, fascia, and the filaments of the radial nerve, until it dips between the first and second metacarpal bones, between the two heads of the origin of the abductor indicis, when between that muscle, and the adductor pollicis, it divides into its terminal branches.

Collateral Branches.—In addition to the several muscular branches, in its course down the fore-arm, it gives off, I. the anterior radial recurrent, II. superficialis volæ, III. anterior carpal, IV. posterior carpal, V. dorsalis manus, VI. princeps pollicis, VII. radialis indicis, and VIII. ramus profundus, vel communicans.

I. ANTERIOR RADIAL RECURRENT.

Arises from the radial, immediately after it comes off from the brachial; it passes at first directly outwards, between the supinator longus, and brevis, and divides into two branches,—an ascending, which passes upwards, to the cleft between the supinator longus and brachialis anticus, to anastomose with the musculo-spiral branch of the superior profunda; and an inferior, to supply the radial extensors of the fore-arm.

II. SUPERFICIALIS VOLÆ.

Variable in size; arises about an inch above the annular ligament, over which, and through the tendinous origins of the muscles of the thumb, it passes to anastomose with the superficial branch of the ulnar, to form the *superficial arch* of arteries.

III. ANTERIOR CARPAL.

Extremely small; arises opposite the styloid process of the radius, passes directly inwards, under the flexor tendons, which it supplies, and anastomoses with a similar branch from the ulnar, with the interosseous, median, and twigs from the deep palmar arch.

IV. POSTERIOR CARPAL.

About the same size as the last; arises from the radial, as it lies in the triangular space already described, passes inwards beneath the extensor tendons, to which it distributes twigs, and anastomoses with the carpal from the ulnar, with the interosseous, and perforating arteries from the deep palmar arch.

V. DORSALIS MANUS.

Variable in size, but always present; it also arises in the triangular space already described; and, passing inwards, along the bases of the metacarpal bones as far as the fifth, forms a species of arch, from the convexity of which it throws off three or four branches, which are distributed to the interossei, and which anastomose with others from the deep palmar arch.

VI. PRINCEPS POLLICIS.

Always comparatively large; arises from the extremity of the radial, as it lies between the abductor indicis and outer head of the flexor pollicis brevis, and passing out, between those two muscles, as far as the base of the first phalanx, divides into two branches, one of which runs on the outer, and the other on the inner, side of the thumb, as far as the middle of the last phalanx, where uniting, they form an arch, from the convexity of which numerous filaments are given off for the supply of the tactile papillæ of the thumb, while from each of its sides a small branch is detached, which, winding backwards and anastomosing at the root of the nail, forms a secondary arch for the supply of its matrix.

VII. RADIALIS INDICIS.

Arises in common with the last, and also runs forwards between the abductor indicis and adductor pollicis, and reaching the base of the first phalanx of the index finger, anastomoses with the princeps pollicis by a cross branch; also, in the absence of the superficialis volæ completing with the superficial branch of the ulnar, the formation of the superficial palmar arch; continuing its course along the radial side of the index finger, it terminates at the middle of the last phalanx, uniting there with the digital branch of the superficial arch, and also sending its twig backwards, to form the ungual arch.

VIII. RAMUS PROFUNDUS, VEL COMMUNICANS.

Very large; arises also in common with the two latter; it turns directly inwards, across the palm of the hand, over the heads of the metacarpal bones and interossei muscles, and under the adductor pollicis, piercing its attachment to the third metacarpal bone, and terminates by anastomosing with the profunda division of the ulnar, thus constituting the *deep palmar arch.*

Anomalies—Of the Radial Artery.—It may arise from the axillary in any parts of its course, or from the brachial in any part of the arm, and in either of these instances, it may run over the semilunar fascia of the biceps; or occasionally it may be so small as to reach only as far as the annular ligament; the ulnar, in this case, supplying by itself the palmar region.

ULNAR ARTERY.

Larger than the radial, with which it arises in common; it passes at first downwards and inwards, and then vertically downwards, to terminate on the inner side of the palm of the hand, by dividing into two branches,—a superficial, and a deep.

Relations.—Anteriorly, pronator teres, median nerve, but separated from it by the coronoid slip of the pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum sublimis, and, at the wrist joint, expansion from flexor carpi ulnaris; posteriorly, brachialis anticus, flexor profundus, and annular ligament; internally, flexor carpi ulnaris, and ulnar nerve, which is at some distance from it in its upper third, close to it in its middle third, but on a plane posterior, but still internal to it, in its inferior third; and externally, junction of the flexor sublimis and flexor profundus.

Remarks.—This artery is very deeply situated above, where it is covered by nearly all the flexors of the fore-arm, but in the inferior third it is quite superficial.

Anomalies.—Like the radial, it may arise in the several positions described under the head of that vessel, and may also descend superficial to the fascia of the biceps, as described by Dr. Butcher, in the *Dublin Medical Press.*

Collateral Branches.—Several muscular, while those which have received distinct names are—1. The anterior; and 2. Posterior ulnar recurrent; 3. Interosseous; 4. Median; 5. Anterior; and 6. Posterior carpal, with its terminal branches; 7. The superficial; and 8. Deep.

I. ANTERIOR ULNAR RECURRENT.

Very small, arising from the front of the ulnar, immediately below the bifurcation of the brachial; it passes upwards and inwards, on the brachialis anticus, and under the pronator teres, and anastomoses with the anastomotica magna.

II. POSTERIOR ULNAR RECURRENT.

Larger than the preceding, with which it often arises in common; it runs upwards and backwards, between the flexor sublimis, and flexor carpi ulnaris, and between the two heads of the latter muscle, and under the ulnar nerve anastomoses with the inferior profunda, and anastomotica magna.

III. INTEROSSEOUS.

A large trunk, about three quarters of an inch in length, arising from the back part of the ulnar, about an inch below its origin; it passes downwards, backwards, and outwards, as far as the tubercle of the radius, where it divides into two branches,—an anterior, and a posterior.

1. Anterior Interosseous.—Extends from the upper edge of the ligament of the same name to the pronator quadratus, where it terminates in supplying that muscle, and in sending a branch backwards, to communicate with the posterior interosseous, posterior carpal, and perforating.

Relations.—Anteriorly, flexor sublimis, and anterior interosseous nerve; posteriorly, interosseous ligament; externally, flexor pollicis; and internally, flexor profundus.

2. Posterior Interosseous passes backwards, through a quadrilateral foramen; bounded superiorly, by the oblique ligament; inferiorly, by the interosseous; and on either side, by the radius and ulna. Arriving now between the superficial and deep extensors, it

breaks up into a lash of branches for the supply of those muscles, and sends one large branch upwards, between the anconæus and supinator brevis, to anastomose with the musculo-spiral, and vertical branches of the superior profunda, and another downwards to communicate, on the back of the carpus, with the anterior interosseous, posterior carpal, and perforating from the deep palmar arch.

IV. MEDIAN BRANCH (OF ULNAR.)

Constant, but very variable in size; arising sometimes from the ulnar, and sometimes from the interosseous trunk; it descends in company with the median nerve, and terminates by anastomosing with the anterior carpal, anterior interosseous, and recurrent branches from the deep palmar arch.

V. ANTERIOR CARPAL.

Very small, arising, as it name implies, opposite the carpus, and, passing outwards, communicates beneath the flexor tendons, with a similar branch from the radial.

VI. POSTERIOR CARPAL

Comes off nearly opposite to the last, winds outwards on the back of the carpus, and under the extensor tendons, and anastomoses with the posterior carpal of the radial.

VII. RAMUS SUPERFICIALIS,

One of the terminal divisions of the ulnar, arising immediately below the annular ligament, passes at first downwards, then winds outwards, and at last terminates by anastomosing with the superficialis volæ, in order to form the *superficial palmar arch.*

VIII. RAMUS PROFUNDUS,

The second terminal branch, sinks between the abductor and flexor minimi digiti, crosses over the bases of the metacarpal bones and interossei muscles, to communicate with the profunda of the radial, and thus form the *deep palmar arch.*

PALMAR ARCHES,

Are two in number—superficial, and deep; the *superficial*, as we have already observed, is formed by the ramus superficialis of

the ulnar, which gives it its greatest supply of blood, and the superficialis volæ of the radial, or where that is absent, by the radialis indicis. The convexity of the arch thns constituted is directed downwards and slightly inwards, pointing to the interval between the little and ring fingers, and it corresponds very nearly to the transverse cleft which is visible during flexion in the palm of every individual.

Relations.—Anteriorly, integument, palmar fascia, and a variable quantity of granular fat; and posteriorly, flexor tendons, with the digital branches of the median nerve, the flattened expansion of which lies superior to it, or within its cnrve.

Collateral Branches.—From its convexity it gives off four, or occasionally five, where the radialis indicis is absent, which are called digital; of these, the most internal is the smallest, and, passing downwards and inwards, rnns along the nlnar side of the little finger, as far as its last phalanx; the second, is larger, and descends to the cleft between the little and ring fingers, and bifurcating, supplies their opposed snrfaces; the third, pnrsnes the same course to the cleft between the ring and middle fingers, dividing for their adjacent aspects; while the fourth, rnnning downwards to the cleft between the middle and indcx fingers, likewise snbdivides, to be distribnted in a similar manner; the arterial supply of the thumb, and of half the index fingcr, being completed by the radialis indicis, and princeps pollicis. All these branches at the distal extremities of the fingers form double secondary arches with each other. One of those arches is found on the anterior surface of each terminal phalanx, and the other on the postcrior aspcct, near the root of the nail; both forming a beautiful capillary plexns, the one for the supply of the tactile papillæ, and the other for that of the matrix of the nail.

Deep Palmar Arch is formed by the rami profnndi of both radial and ulnar arteries, but differs from the superficial, in being smaller, more transverse, and situated much ncarer the carpus.

Relations.—Anteriorly, supcrficial and dccp flexors, origin of adductor pollicis, and decp process of palmar fascia, all of which separate it from the snperficial arch; posteriorly, heads of metacarpal bones, and interossei muscles.

Collateral Branches.—1. Antcrior, or digital; 2. Posterior, or perforating, and 3. Supcrior, or carpal.

I. ANTERIOR, OR DIGITAL.

Generally three or four in numbcr, which arise from the convexity of the arch, and run forwards along the interosseal spaces, and at

the clefts between the fingers turn upwards, to anastomose with the digital branches of the superficial palmar arch, before their division.

II. POSTERIOR, OR PERFORATING,

Are similar in number to the preceding, but spring from the deep surface of the arch; they pass backwards, piercing the interossei muscles, which they supply, and then ascend to the back of the carpus, where they anastomose with the interosseous, and the carpal.

III. SUPERIOR, OR CARPAL.

Two or three small twigs, which arise from the concavity of the arch, beneath the anterior annular ligament, and pass upwards, to anastomose with the anterior interosseous, and the anterior carpal.

Anomalies of the Arches.—The superficial, is sometimes constituted by the ulnar alone, which divides into the ordinary number of digital branches, or, as we have before observed, by uniting with the radialis indicis; while the deep arch, is sometimes formed by the radial only, the profunda of the ulnar being so small as scarcely to be said to give it any blood. With respect to the use of the two arches in the hand, its object would appear to be, to obviate the effects of pressure, which in its grasping motions would have a tendency to cut off its arterial supply, if it was dependent solely on the blood from a single source.

THORACIC AORTA.

The direct continuation of the descending portion of the arch, commences opposite the inferior margin of the third dorsal vertebra, and descending almost vertically, along the left side of the spine, terminates opposite the tenth dorsal vertebra.

Relations.—Anteriorly, pericardium, œsophagus, and pneumogastric nerves; posteriorly, vertebræ, anterior vaginal ligament, and intervertebral substance, intercostal arteries, and left intercostal veins, with the emi-azygos vein; to the right side, thoracic duct, and vena azygos; and to the left, pleura and lung, and dorsal ganglia of sympathetic.

Remarks.—It will be recollected that although the œsophagus lies anterior to this vessel below, it is to its right side above, while the thoracic duct, although to its right below, is partially posterior to it above. The point, where the lesser azygos crosses beneath it to join the greater, is usually opposite the fifth, or sixth dorsal vertebra.

Anomalies.—None, except from transposition.

Collateral Branches.—1. Bronchial; 2. Œsophageal; and 3. Intercostal.

I. BRONCHIAL,

Are generally two in number; they arise from the upper part of the thoracic aorta, and passing upwards and forwards, to the back part of the root of the lung, attach themselves to the posterior wall of the bronchial tubes, accompanying them into the substance of the lungs, supplying those tubes, as well as the pulmonary parenchyma; they also send branches to the œsophagus, and left ventricle of the heart. It has been supposed that their *effête* blood is taken up by the pulmonary arteries; but this has never been proved to be the fact; and it is more rational to suppose it to be effected by the bronchial veins.

Anomalies.—They may spring, either from the descending portion of the arch, or from the superior intercostals, or from the internal mammary.

II. ŒSOPHAGEAL.

Usually very small, and about six in number; they arise from the front of the aorta, and passing outwards, reach the anterior surface of the œsophagus, perforate its cellular and muscular coats, and are lost in the submucous tissue, anastomosing above, with the bronchial and twigs from the inferior thyroid; and below, with the coronary, and left phrenic.

III. INTERCOSTAL.

Intercostals.—Nine on the right side, and ten on the left; they arise from the back part of the thoracic aorta, and pass, the superior upwards and outwards, the middle horizontally outwards, and the inferior downwards and outwards, to terminate at the intertransverse space, by dividing into an anterior, and a posterior branch.

Relations.—On right side:—Anteriorly, œsophagus, pneumogastric nerves, thoracic duct, and vena azygos; posteriorly, bodies of the vertebræ, and anterior common ligament. On the left side, the five or six inferior, run behind the azygos minor; and the two last, under the attachments of the crura of the diaphragm.

1. Anterior Branch, from its direction, must be considered the common trunk; it passes directly outwards, on the anterior costo-transverse ligament, then on the external layer of intercostals, and covered by the pleura as far as the angle, where it enters between the two layers of the intercostal muscles, winds upwards to the inferior margin of the rib above, where it has its corresponding vein above it, and its nerve below it; and with these relations it proceeds to the anterior third of the rib, and dipping downwards, terminates

by anastomosing with the internal mammary, phrenic, and lumbar. A little beyond the angle, it always throws off a small branch, which runs on the upper margin of the rib below, and is lost in supplying the intercostal muscles.

2. Posterior Branch.—Smaller than the anterior; it passes directly backwards, through a quadrilateral space, bounded above and below, by the transverse processes; externally, by the anterior costo-transverse ligament; and internally, by the bodies of the vertebræ; it is distributed to the erectors of the spine, and integument, and anastomoses with the branches from the opposite artery. As it passes through the intertransverse space, it throws off a small branch, which enters the spinal canal through the intervertebral hole, and communicates with the spinal arteries; while a slender filament runs on the back part of the body of the bone, and arriving at the venous foramen, in its middle, bifurcates, the branches above and below, anastomosing with similar ones from the opposite side—thus constituting a circle, from which numerous ramusculi enter the cancellous structure of the bone itself for its supply.

Between the lower portion of the tenth dorsal vertebra, and upper edge of the first lumbar, the aorta occupies a space, which from its position, cannot be strictly called either thoracic or abdominal, the interval being, in fact, a kind of neutral ground between the two. The aperture is funnel-shaped, dilated superiorly, but so constricted inferiorly, that when the vessel is fully injected with paint, it will only with much difficulty, admit the thin handle of a scalpel to be insinuated beneath it. The order of parts, as they pass through this opening, is as follows:—To the right side, the vena azygos; next in order and to the left, the thoracic duct; next, the aorta, with the sympathetic nerve behind it; and occasionally, and still more to the left, the splanchnic nerve.

ABDOMINAL AORTA,

Is a direct continuation of the thoracic, it descends between the crura of the diaphragm, through the tendinous aortic opening, on the left side of the vena azygos, and thoracic duct, and becomes abdominal at the inferior margin of the twelfth dorsal vertebra; from this point it extends to the left side of the body of the fourth lumbar, where it bifurcates into the two common iliac.

Relations.—Anteriorly, tendinous arch of diaphragm, posterior thick margin of liver, ascending layer of transverse mesocolon, solar plexus, cœliac axis, pancreas, formation of vena portæ, superior mesenteric artery, inferior transverse portion of duodenum, left renal vein, root of mesentery, inferior mesenteric artery, and descending

layer of transverse mesocolon; posteriorly, left crus of diaphragm, left side of vertebral column, with its connecting media, receptaculum chyli, left lumbar veins, and middle sacral artery; to the right side above, right crus of diaphragm, thoracic duct, vena azygos, and lobulus Spigelii of liver,—and below, the vena cava ascendens; to the left, the left crus of the diaphragm, semilunar ganglion, and sympathetic nerve, with the spleen, kidney, and descending colon.

Remarks.—It will be observed, that although the aorta may be said generally to lie on the left side of the vertebral column, yet both above and below, it approximates to the mesial line, so as to present a slight concavity towards the right side.

Anomalies.—Variable only as far as its point of bifurcation is concerned, as it may divide either higher up, or lower down, than the point indicated.

Collateral Branches.—Have been divided into those which arise singly, as I. the cœliac axis, II. superior, and III. inferior mesenterics, and IV. middle sacral; and into those which arise in pairs, as V. the phrenic, VI. capsular, VII. renal, VIII. spermatic, and IX. lumbar; their order of origin from above downwards being :—I. Phrenic; II. Cœliac axis; III. Superior mesenteric; IV. Capsular; V. Renal; VI. Spermatic; VII. Inferior mesenteric; VIII. Lumbar; and IX. Middle sacral.

I. PHRENIC.

Very variable in size; they arise from the aorta, immediately below its tendinous arch, and pass upwards and outwards, each in front of its corresponding crus; the right lying behind the cava, and the left behind the œsophagus; on reaching the sides of the cordiform tendon they divide each into two branches,—an external, which passes outwards, to anastomose with the lower intercostals; and an internal, which runs inwards, towards the xiphoid cartilage, to communicate with the internal mammary. Immediately after its origin, the phrenic almost constantly sends down a branch to the suprarenal capsule, to anastomose with its arteries, and with the renal.

Anomalies.—Both may arise by a common branch from the parent trunk, or from the cœliac axis, or occasionally from the renal.

II. CŒLIAC AXIS.

A thick, short trunk, about half an inch in length; arises from the left side of the aorta, from which it stands out at nearly a right angle, opposite the first lumbar vertebra.

Relations.—Above, tendinous arch of diaphragm; below, pancreas,

which separates it from the superior mesenteric artery; in front, concave margin of stomach, and lesser omentum; on each side the corresponding crus, semilunar ganglion, and suprarenal capsule, with the addition on the right side and superiorly, of the lobulus Spigelii of the liver; while it is encircled by branches of the solar plexus.

Collateral Branches.—Coronary or gastric, hepatic, and splenic.

1. Coronary or Gastric.—The smallest of the three; it passes upwards and towards the left side, as far as the cardiac orifice of the stomach, where it throws off a large branch, the œsophageal, which ascends on the œsophagus to anastomose with similar twigs from the thoracic aorta, as well as some branches to the great extremity of the stomach. Having given off these, it next takes a recurrent direction downwards and to the right side, between the layers of the lesser omentum, and about half an inch from the concave margin of the stomach, anastomoses near the pylorus with the superior pyloric, from the hepatic, thus constituting an arch, from the convexity of which branches are detached, for the supply of both the anterior and posterior surfaces of the stomach; those branches communicate with similar offsets from the epiploic arch.

3. Hepatic.—This is much larger than the coronary, and extends from the cœliac axis, as far as the transverse fissure of the liver; but because in its course it presents a well-marked angle, it has been divided into two stages,—a transverse, running directly to the right side, nearly as far as the ductus communis choledochus; and a vertical from the latter point, to within an inch of the transverse fissure, where it divides into two branches,—a right, and a left, which enter the extremities of the fissure, to be distributed to the hepatic structure as vaginal, interlobular, and lobular branches.

Relations—First Stage.—Anteriorly, pyloric extremity of stomach and lesser omentum; posteriorly, right crus of the diaphragm, semilunar ganglion, vena portæ, and cava, crossing also the vena azygos, and thoracic duct; inferiorly, upper margin of pancreas; and superiorly, lobulus Spigelii, and foramen of Winslow.

Second Stage.—Between the layers of the lesser omentum, to the left side of the duct, and in front of the porta.

Anomalies.—It may arise, either separately from the aorta, or from the superior mesenteric; and the left frequently arises from the coronary.

Collateral Branches.—Superior pyloric, gastro-duodenalis, and cystic.

a. Superior Pyloric.—Generally small; may arise either before or after, and sometimes from the gastro-duodenalis; it curves downwards and backwards, between the layers of the lesser omentum, and anastomoses with the coronary.

b. Gastro-Duodenalis.—Very large, arises from the angle of division between the transverse and vertical stages of the hepatic, and at the upper edge of the pancreas divides into gastro-epiploica dextra, and pancreatico-duodenalis. Immediately before its division, it throws of a few small twigs, known as the inferior pyloric, which supply that part, and anastomose with the superior pyloric.

Relations.—Anteriorly, superior transverse portion of duodenum; posteriorly, right crus of diaphragm and vena portæ; and to the right side, ductus communis choledochus.

Gastro-epiploica Dextra.—In size, the continued trunk; it runs downwards and to the left side, between the layers of the great omentum, and along the convex margin of the stomach, inosculating with the gastro-epiploica sinistra from the splenic, while from the arch thus formed, branches are given off to the anterior and posterior surfaces of the stomach, as well as to the glands of the omentum.

Pancreatico-duodenalis.—Smaller than the preceding; it passes at first downwards, between the head of the pancreas and vertical portion of duodenum, in front of the ductus communis choledochus, then winds between the inferior transverse portion of the duodenum and the lower edge of the pancreas, and ultimately, after supplying both these latter structures, anastomoses with the superior mesenteric.

c. Cystic.—An exceedingly small branch, which may arise either from the hepatic trunk, or its right division; it runs downwards, forwards, and to the right side, between the cystic and right hepatic ducts, and divides into two branches, one of which is distributed to the coats of the gall-bladder, and the other to the tissue of the liver beneath it.

Terminal Branches of the hepatic are two in number, a right, and a left, the former being the larger; both enter the corresponding extremities of the transverse fissure of the liver, and immediately break up into the following series of branches:—Firstly, the vaginal, so called from the sheath derived from the capsule of Glisson, which invests them; secondly, the interlobular, so termed from occupying the fissures of the same name; and thirdly, the lobular, being so designated from ramifying on the ultimate lobules, and there forming a complicated plexus, the effête blood being taken up by the vena portæ, which acts as its satellite vein.

3. Splenic.—The largest of the three branches of the cœliac axis, and remarkable for its tortuosity; it passes at first downwards, then upwards, and to the left side, to within an inch and a half of the hilus of the spleen, where it divides into five or six branches, which are distributed to that viscus (see its Anatomy).

Relations.—Anteriorly, upper margin of pancreas, which it also grooves; and posteriorly, left crus, semilunar ganglion, and psoas muscle, with its own vein, which is likewise slightly inferior to it.

Anomalies.—It may arise separately from the aorta.

COLLATERAL BRANCHES.—Lesser, and greater pancreatic, gastro-epiploica sinistra, and vasa brevia.

a. LESSER PANCREATIC, are small, and usually four or five in number, which enter the pancreas for its supply, and anastomose with each other, and with the following:—

b. GREATER PANCREATIC.—Of a medium size; it buries itself in the substance of the gland, and accompanies its duct, to which it is principally supplied.

c. GASTRO-EPIPLOICA SINISTRA, comes off in common with the proper splenic, and winds downwards and towards the right side, between the layers of the great omentum, on the great curvature of the stomach, where it anastomoses with the gastro-epiploica dextra, a branch of the gastro-duodenalis.

d. VASA BREVIA.—Short, thick branches, which run between the splenic omentum, supply the large extremity of the stomach, and anastomose with the coronary.

Remarks.—All the branches of the cœliac axis, with their subdivisions, are remarkable for their free inosculations, so much so that it is often difficult to determine where the one commences and the other terminates; and hence is apparently the cause why such an extreme variation exists in the size of the anastomosing branches, the rule of compensating power, in cases of deficiency in capacity in either, being here remarkably applied in the augmented volume of either one or the other.

III. SUPERIOR MESENTERIC

Arises from the left side of the aorta, opposite the second lumbar vertebra, below the pancreas, which separates it from the cœliac axis, and above the inferior transverse portion of the duodenum, and the left renal vein; it descends at first downwards, forwards, and towards the left side, and then, arching across the lower part of the abdomen, terminates in the right iliac fossa, where it becomes the ileo-colic branch.

COLLATERAL BRANCHES.—1. A series of branches to small intestines; 2. Colica media; 3. Colica dextra; and 4. Ileo-colic.

1. SMALL INTESTINAL BRANCHES.—Fifteen or sixteen in number, springing from the convexity of the arch, and passing outwards and downwards, between the layers of the mesentery, for about two or three inches, when each bifurcates, the secondary branches anasto-

mosing with similar ones from the arteries above and below, this process being repeated two, three, or four times till they reach the small intestine, where they terminate in slender filaments which form loops around it, and are distributed to the muscular tunic of the gut. The remarkable anastomoses exhibited by those arteries, is an example of one of those beautiful provisions of nature which we find so lavishly displayed in the human body, the object in this instance being to equalize the amount of blood which each portion of the small intestine should receive, and which otherwise might have been interrupted in any one particular spot by the induration or enlargement of the mass of the mesenteric glands, with which they are so intimately intermingled.

2. Colica Media, arises from the superior mesenteric, immediately after its commencement, and passes downwards and forwards, between the layers of the transverse mesocolon, to within an inch of the transverse colon, where it divides into two branches, a right and a left, the right anastomosing with the ascending branch of the colica dextra; and the left, with that of the colica sinistra, the one arch supplying the hepatic, and the other the splenic flexure of the colon.

3. Colica Dextra, arises from the concavity of the artery, a little below its middle; it passes downwards, and towards the right side, beneath the right lumbar mesocolon, and divides into two branches, the superior of which ascends, to anastomose with the right of the colica media; while the inferior descends, to communicate with the ilio-colic, the latter arch supplying branches to the lower part of the ascending colon.

4. Ileo-colic.—Really the termination of the mesenteric itself, which, bifurcating, anastomoses below with one of the small branches from its convexity, and above with the colica dextra; and is distributed principally to the termination of the ileum, cœcum, and vermiform process.

Remarks.—The superior mesenteric at its origin gives branches to the pancreas, and to the great omentum.

Anomalies.—It may spring from the cœliac axis.

IV. CAPSULAR, OR SUPRARENAL.

Extremely small, arising from the sides of the aorta, opposite the cœliac axis; they pass outwards over the corresponding crura, and are distributed to the suprarenal bodies, anastomosing with the renal, and the phrenic.

V. RENAL, OR EMULGENT.

Very large; they pass out nearly at a right angle from the sides

of the aorta, and about an inch from the hilus of the kidney, break up into four or five branches, which enter the substance of that organ (see ANATOMY OF KIDNEY).

Relations.—Right side:—Anteriorly, right and left renal veins and cava; posteriorly, crus of diaphragm, psoas, and ureter. Left side:—Anteriorly, left renal vein only and posteriorly, same as right.

Remarks.—The left vein frequently lies behind its corresponding artery.

Anomalies.—They may arise by a common trunk from the front of the aorta.

VI. SPERMATIC.

Long, slender branches, which arise from the front of the aorta, below the renal, and extend downwards, as far as the scrotum, where they terminate by dividing into two, one for the epididymis, and another for the testicle, anastomosing with the cremasteric from the deep epigastric, and the deferential from the umbilical. They are divided into two stages,—an abdominal, and a scrotal.

Relations.—*First Stage.*—Anteriorly, peritonæum, ureter, last coil of the ileum on the right, and sigmoid flexure on the left; posteriorly, psoas muscle and outer edge of the external iliac artery. In this stage, the right may lie either before or behind the cava, and the relation of the ureter to both is also very variable. Contrary to what is here stated, our observation in an immense number of instances would lead us to place the ureter always behind the artery and not in front of it, but we feel diffident in advancing an opinion directly at variance with so many standard authorities. In leaving the abdominal cavity, which they do through the internal ring, they both pass between the vas deferens and the epigastric artery, but are separated from the latter by one of its own venæ comites. In its *second stage* it descends through the oblique inguinal canal, behind the spermatic veins, and in front of the cord, escapes through the external ring, and runs downwards over the front of the pubis to the upper part of the epididymis, where it divides, as already explained. The testicular branch, entering the testicle at its upper part, and passing between the layers of the mediastinum testis, is distributed by fine filaments to the septa of the testis, forming the tunica vasculosa of Sir A. Cooper, while the other is devoted to the supply of the epididymis. In the female, the spermatic arteries are shorter and thicker, and are destined for the ovaries, passing into the pelvis over the common iliac arteries, and then entering the broad ligaments.

Remarks.—Owing to the anastomoses in the scrotal cavity, the spermatic arteries are fully as large at their termination as at their

origin; and in their descent, aneurismal dilatations are frequently found on them.

Anomalies.—They may arise from the renal, in fact they frequently do so; or from the common iliacs.

VII. INFERIOR MESENTERIC.

Much smaller and shorter than the superior; it arises from the left side of the aorta, opposite the third lumbar vertebra, and, passing downwards, as far as the left sacro-iliac synchondrosis, terminates in the superior hæmorrhoidal.

COLLATERAL BRANCHES.—1. Colica sinistra; 2. Arteria sigmoidea; and 3. Superior hæmorrhoidal.

1. COLICA SINISTRA, runs upwards and outwards, over the left kidney, and beneath the left lumbar mesocolon, and divides into two branches, of which the superior ascends to anastomose with the left branch of the colica media, and the inferior descends to communicate with the superior of the colica sigmoidea; from the arches thus formed, numerous branches are given off to supply the sigmoid flexure and descending colon.

2. ARTERIA SIGMOIDEA, arises below the last, and passes downwards and outwards, towards the left iliac fossa, beneath the peritonæum, and divides into two branches,—a superior, to anastomose with the colica sinistra; and an inferior, with the superior hæmorrhoidal; their loops of communication supplying the lower part of the descending colon, and of the sigmoid flexure.

3. SUPERIOR HÆMORRHOIDAL.—The terminal branch of the inferior mesenteric; it passes downwards, backwards, and inwards, beneath the peritonæum, and over the psoas, ureter, common iliac artery and vein, and entering the fold of the meso-rectum, descends on the back part of the rectum to where the serous membrane is reflected along its sides, and there divides into two branches which embrace it laterally, from which numerous ramusculi are detached for the supply of its walls, and to anastomose with the middle and inferior hæmorrhoidal, from the internal iliac and pudic.

Remarks.—The inferior mesenteric, is always very regular in its origin and termination, and both it and the superior are remarkable for the arched arrangement of their branches, the object of which is probably to provide means of equalizing the circulation.

VIII. LUMBAR.

Generally four, sometimes five in number; they arise from the back part of the aorta, and pass outwards, over the bodies of the vertebræ,

and beneath the looped origins of the psoas; the superior pass under the crura of the diaphragm. Arriving at the intertransverse spaces, they divide into two branches,—an anterior, which runs outwards over the quadratus lumborum, and under the transversalis aponeurosis, to anastomose with the intercostals and ilio-lumbar; and a posterior, which winds backwards through the intertransverse space, to reach the erectors of the spine, which it supplies. This latter always gives off a small twig, which enters the spinal canal, through the foramen of conjugation, to supply the body of the bone, and to communicate with the proper spinal.

Remarks.—If there are five lumbar, the last is usually given off by the common iliac.

IX. MIDDLE SACRAL.

Very variable in size; it arises from the back part of the aorta, about half-an-inch above its bifurcation, and descends in the mesial line as far as the coccyx, where it divides into two branches, which anastomose, in reversed arches, with the lateral sacral.

Relations.—Anteriorly, aorta, left common iliac vein, meso-rectum, and rectum itself; posteriorly, sacrum and coccyx; and laterally, sympathetic chain of nerves, which separates it from the lateral sacral.

Remarks.—This artery, in its descent, throws off branches, which enter through the anterior sacral foramina, and emerge by the posterior, to anastomose with the superficial glutæal.

COMMON ILIACS.

These arteries take their origin from the aorta, as the rule, at the left side of the body of the fourth lumbar vertebra, and extending from this point downwards and outwards, terminate a little internal, but opposite, to the corresponding sacro-iliac synchondrosis, by dividing into the internal and external iliacs; the left is generally a little shorter than the right, owing to the position of the aorta where it divides.

Relations.—On the left side:—Anteriorly, peritonæum, sigmoid flexure, superior hæmorrhoidal artery, and ureter; posteriorly, side of body of last lumbar vertebra, connecting ligaments, sympathetic nerve, and shoulder of sacrum, obturator nerve, and transverse branch of middle sacral artery; externally, psoas, and spermatic arteries and veins; and internally, its own vein.

Right side:—Anteriorly, peritonæum, last coil of ileum, and ureter; posteriorly, similar to those on left side, with, in addition, its own vein, that of the opposite side, and commencement of inferior cava: externally, psoas, and spermatic vessels; and internally, middle sacral artery.

Remarks.—It will be observed that the vein of the left side does not lie behind, but internal to, its eorresponding artery, while that of the right is slightly internal to it below, direetly posterior to it in the middle, and slightly external to it above; the lumbo-saeral nerve is also posterior and internal to both vessels, bnt at some distance from them.

Anomalies.—They are sometimes altogether defieient, as the internal and external iliacs may arise independently, from the aorta; their length is also very variable, as they may range from one to three inehes: oecasionally, thcy give origin to the last lnmbar artery.

INTERNAL ILIAC.

Opposite and internal to the saero-iliac symphysis, the common iliac bifureates into the external and internal iliacs, the former vessel being the longer aud larger, thongh in fœtal life the exact reverse obtained, the latter preponderating in both measnrements. In the adnlt therefore, the internal iliac eommenees at the point indicated, and passing downwards, backwards, and outwards, terminates at the upper part of the sciatic notch, in a trnnk common to the pudic and sciatic arteries.

Relations.—Anteriorly, recto-vesical fold of peritonæum and ureter; posteriorly, lumbo-sacral nerve, ilio-lnmbar and glutæal arteries, which separate it from the bone; internally, origin of pyriformis, exit of saeral nerves from the foramina, lateral and middle sacral artcries, with sympathetie nerves; and externally, obturator nerve, artery, and vein, whieh are also somewhat superior to it. On the left side, thc corresponding vein lies almost directly posterior, yet slightly internal to it; bnt on the right, while still posterior, it is also a little external to it.

Remarks.—In fœtal life, this artery is continued, as the nmbilical, to the navel, and at this period it traversed, not the pelvic, but the abdominal region, in its course describing a well-marked curve, the eoneavity of whieh looked upwards and forwards; but the ligature applied to the cord, at the moment of birth, produeed an obliteration of this vessel, as far as the bladder, the deseent of which into the true pelvis caused also a change in its direetion, the eoncavity of the curve whieh it forms in the adult, being the opposite to that in the fœtns, viz., upwards and baekwards. We have observed this to be the case in the numerous instanees which we have examined, and the very shape of the bone over whieh it passes, and the traction exercised by the glntæal artery, are amply sufficient to eonfirm this view. We have omitted mentioning as posterior relations, either the sacral plexus or pyriformis muscle; because, if the artery, as generally

admitted, terminates at the upper margin of the great sciatic uotch, it is impossible that it could rest on either one or the other.

Anomalies.—These are only such as refer to its varieties of length, its average being from one inch to an inch and a half, or to its point of origin or termination, which may be either above or below the situation indicated.

Collateral Branches are classed into those within, and those without the pelvis; the former, being five in number, viz., 1. Ilio-lumbar; 2. Middle hæmorrhoidal; 3. Lateral sacral; 4. Vesical; and 5. Umbilical; with 6. Uterine, and 7. Vaginal, in the female; while the latter are four, viz., 8. Glutæal; 9. Obturator; 10. Sciatic; and 11. Pudic.

I. ILIO-LUMBAR.

Usually a large branch, arising from the outer and back part of the internal iliac; it passes upwards, outwards, and backwards, and terminates in three branches, one of which ascends uuder the psoas to anastomose with the lumbar; the second, runs outwards to the posterior part of the crest of the ilium, aud across the iliac fossa, either under, or over, or through the iliacus iuternus, to communicate with the glutæal and internal circumflex ilii; while the third passes downwards aud outwards, close to the bone, to which it sends a large branch, and at the anterior superior spinous process, anastomoses with the circumflex branches of the femoral, exterual iliac, and profunda.

Relations of Ilio-lumbar Trunk.—Anteriorly, external iliac artery and vein, obturator, and anterior crural nerve, and psoas muscle: posteriorly, ilio-sacral symphysis, and lumbo-sacral uerve, which it separates from the obturator.

II. MIDDLE HÆMORRHOIDAL,

Arises from the front of the iuternal iliac, aud passing downwards and forwards, below the recto-vesical fold of peritonæum, reaches the sides of the rectum, aud divides into uumerous long branches for the supply of that gut, anastomosing with the superior hæmorrhoidal from the inferior meseuteric, aud the inferior hæmorrhoidal from the pudic.

III. VESICAL,

Are geucrally three in number, aud termed the posterior, anterior, and superior. The first, is usually a brauch from the middle hæmorrhoidal, which ruus at first downwards aud forwards, to the eutrance

of the ureter, and then ascends on the lateral regions of the bladder; the second, is given off by the internal iliac itself, and passes forwards along the inferior fundus of the bladder, supplying it, and the commencement of the urethra; while the third, is derived from the obliterated umbilical, its twigs being distributed to the superior fundus; other branches are also occasionally given off to the bladder from the obturator, pudic, and sciatic. They all ramify in the cellular coat of this viscus, and anastomose in complete circles around it.

IV. LATERAL SACRAL.

Variable in size; it arises from the back part of the internal iliac, and passes downwards and inwards, over the origins of the pyriformis, and points of emergence of the sacral nerves; and reaching the coccyx, anastomoses, by reversed arches, with the middle sacral, from which it is separated, in its course downwards, by the sympathetic nerve. This vessel, as it descends, throws off branches, which, entering by the anterior sacral foramina, again emerge, after supplying the cauda equina through the posterior; on the back of the sacrum, it anastomoses with the superficial branches of the glutæal.

V. UMBILICAL.

Usually known as the obliterated hypogastric, but, as already observed, it invariably continues patulous to the upper fundus of the bladder, constituting the superior vesical artery; at this point a small twig is always detached from it (deferential branch of Sir A. Cooper), which accompanies the vas deferens as far as the epididymis, where it anastomoses with the spermatic, and cremasteric arteries.

VI. UTERINE,

Arises, in common with the inferior vesical, from the termination of the internal iliac, passes forwards to the neck of the uterus, and, ascending along its sides, divides into anterior and posterior branches for the front and back of the uterus, which can be traced as high as its fundus, and which become remarkably large and tortuous during pregnancy.

VII. VAGINAL,

Arise, sometimes in common with the uterine, and sometimes anterior to them; they pass forwards, along the sides of the vagina, and divide into a series of branches which supply its walls and the

neck of the bladder, anastomosing freely with each other; they are always very large in the young subject.

VIII. GLUTÆAL.

The largest of the external branches, arises from the back part of the internal iliac, about half an inch before its termination; it passes downwards and backwards, to the upper edge of the great sciatic notch, leaves the pelvis through that aperture, and divides almost immediately into its terminal branches, superficial, and deep; and hence it must be divided into an intra- and an extra-pelvic stage.

Relations of the Intrapelvic Stage.—Anteriorly, peritonæum, internal iliac artery, and vein; and posteriorly, communicating branch of the lumbo-sacral nerve, which separates it from the bone, and then becomes external to it. In this stage, it is surrounded by a quantity of hard condensed areolar tissue of a yellow colour, which is always extremely difficult to be removed. On reaching the upper margin of the great sciatic notch, the glutæal having thrown off a large branch which enters through a foramen in the bone, and which anastomoses in its cancellous structure with the ilio-lumbar, then emerges between the communicating branch of the lumbo-sacral and first sacral nerves; next between the margin of the notch, which it grooves, and the pyriformis muscle, and at last stands boldly out between that muscle and the posterior margin of the glutæus minimus; in this course it is accompanied by the superior glutæal nerve, which lies anterior and external to it, and by the glutæal vein, which is posterior to it. Dividing now into two branches,—a superficial, and a deep, the former enters the substance of the glutæus maximus, and separates into a number of long, slender ramusculi, some of which pass upwards, to the posterior part of the crest of the ilium, to anastomose with the ilio-lumbar and internal circumflex ilii; some run upwards and backwards, to the posterior surface of the sacrum, to communicate with the perforating branches of the middle and lateral sacral: while others again pass downwards and backwards, to the coccyx, perforate the sciatic ligaments, and anastomose with the coccygeal branch of the sciatic. The latter, or profunda, division of the glutæal divides almost invariably into three branches,—a superior, middle, and inferior: the first, winds upwards and forwards, between the glutæi medius and minimus, following the curved origin of the latter muscle, and at the anterior superior spine of the ilium, anastomoses with the ilio-lumbar, and the circumflex of the femoral, and external iliac; the second or middle, runs forwards, still between the same muscles, but across the middle of the glutæus minimus, to the anterior inferior spine, where it communicates with the ascending

division of the external circumflex of the profunda; while the third, or inferior, descends along the posterior margin of the glutæus minimus, which it afterwards perforates, and entering the digital fossa, anastomoses with the obturator, sciatic, and internal circumflex of the profunda.

Remarks.—One of the most regular arteries in the human body.

IX. OBTURATOR.

Arises from the outer and anterior side of the internal iliac, and, passing downwards, forwards, and outwards, leaves the pelvis through the upper part of the thyroid foramen, and terminates on the inner region of the thigh, by dividing into two terminal branches; it also has been divided into two stages,—one within, and one without the pelvis.

Relations.—Within the pelvis;—Superiorly and anteriorly, obturator nerve; inferiorly and posteriorly, obturator vein; externally, wall of the pelvis and origin of levator ani; and internally, peritonæum. In this stage, it is always invested in loose areolar tissue. On reaching the thyroid foramen, it sends off a small branch which runs inwards, above the neck of the bladder, and behind the symphysis, to anastomose with its fellow of the opposite side; and then perforating the vesical fascia, some fibres of the levator ani, obturator fascia, obturator internus, obturator membrane, and obturator externus, reaches the inner side of the thigh, or its second stage, where it lies in a kind of recess, bounded in front by the pectinæus, behind by the quadratus femoris, and upper margin of the adductor magnus; externally by the neck of the femur, capsular ligament, and psoas, and iliac muscles; internally, by the adductores brevis and longus; and superiorly, by the obturator externus; here it throws off some twigs to the hip-joint, and then divides into two branches,—an internal which passes downwards and inwards along the inside of the obturator muscle, supplying the origins of the adductors, sides of the scrotum, and labia in the female, and anastomosing with muscular branches of the femoral; and an external, which runs on the outside of the obturator muscle, accompanying its tendon to the digital fossa, where it communicates with the sciatic, glutæal, and internal circumflex of the profunda.

Anomalies.—This, according to our observations, is more liable to variation than is generally supposed, and in the session before last especially, nearly every subject that was brought into the dissecting-room exhibited the anomalous origin from the epigastric, and not from its ordinary source. When this abnormal condition of the vessel exists, its importance, so far as femoral hernia is con-

cerned, is obvious, as its course is at first directly inwards, parallel to, but above Poupart's ligament, then backwards, along the base of Gimbernat's, or more properly, Hey's ligament ; next outwards, for a short distance along the pectineal line, and ultimately downwards, backwards, and outwards, to the subpubic canal. In an instance of this kind, it is quite clear that it must embrace nearly three-fourths of the neck of the sac, and this in a most dangerous position, lying as it does in the direction of the edge of the knife, as it divides the stricture at the point of strangulation. But again, this anomaly may prevail, and yet be attended with no danger, as the vessel may pass to its destination between the neck of the sac and the external iliac vein, a course which it very frequently pursues. The obturator artery may also arise from the internal circumflex of the profunda, and the external iliac, or, according to Burns, from the femoral ; and once only we observed it taking an origin, on one side, from the dorsal artery of the penis.

X. SCIATIC.

This almost always arises by a common trunk with the pudic, which it always exceeds in size ; it passes downwards, forwards, and outwards, and leaves the pelvis through the lower part of the great sciatic notch, where it divides into its ultimate branches. This vessel has also been divided into two stages, or one within, and one without the pelvis.

Relations—First Stage.—Anteriorly, rectum, bladder, and vesiculæ seminales ; posteriorly, pyriformis, sacral plexus, and pelvic facia ; externally, pudic artery ; and internally, middle sacral.

Now leaving the pelvis below the pyriformis, above the lesser sciatic ligament, and posterior to the spine of the ischium, it stands boldly out in its second stage, beneath the glutæus maximus, and posterior to, or nearer, the sacrum than the great sciatic nerve, and here it divides into its terminal branches,—viz., 1, coccygeal ; 2, comes nervi ischiadici ; and 3, muscular.

1. Coccygeal.—Generally large, arising from the back part of the sciatic, it passes backwards and inwards, over the pudic artery, and between the greater and lesser sciatic ligaments, and reaching the coccyx, anastomoses with the glutæal, lateral, and middle sacral.

2. Comes Nervi Ischiadici.—A slender, but long branch ; it runs at first downwards, on the back part of the great sciatic nerve, then, perforating it, descends in its substance as far as the knee-joint, where it anastomoses with branches of the poplitæal.

3. Muscular.—Several twigs to the adjacent muscles, one of

which always runs to the digital fossa, to anastomose with the glutæal, obturator, and internal circumflex of the profunda.

XI. PUDIC.

This is the longest and most important of the branches of the internal iliac; it usually arises from a common trunk with the sciatic, and, pursuing a very tortuous course, terminates at the corona glandis in the male, and the labia in the female. In order to understand its relations with greater facility, it has been divided into three stages, two intrapelvic, and one extrapelvic—the first, extending from its origin to its exit from the pelvis through the great sciatic notch (intrapelvic); the second very short, where it crosses the spine of the ischium (extrapelvic); and the third, from its re-entrance into the pelvis till it reaches the subpubic ligament (intrapelvic).

Relations—First Stage.—Anteriorly, rectum, bladder, and vesiculæ seminales; posteriorly, pyriformis, sacral plexus, and pelvic fascia; internally, sciatic artery; and externally, the parts as they emerge from the greater sciatic notch. As it passes through the aperture, it winds beneath, and becomes anterior to the sciatic artery; and has above it the pyriformis, and below it the lesser sciatic ligament.

Relations—Second Stage.—Anteriorly, spine of the ischium, or sometimes insertion of lesser sciatic ligament; posteriorly, external falciform process of great sciatic ligament, and glutæus maximus; superiorly, pudic vein; and inferiorly, pudic, and obturator nerves. It now re-enters the pelvis through the lesser sciatic notch, but is separated from the bone by the tendon of the obturator internus, which is escaping at the same place, and here its third stage commences.

Relations—Third Stage.—Externally, tuber ischii, and obturator internus; internally, obturator fascia, in a tubule of which it is invested; and inferiorly, internal falciform process of the great sciatic ligament. Having occupied this triangular groove, as far as the anterior part of the tuberosity, it now perforates the base of the posterior layer of the triangular ligament, runs between it and the anterior for about half an inch, and then, piercing the anterior, ascends upwards, forwards, and inwards, between the crus penis, which is anterior and inferior to it, the anterior layer of the triangular ligament, which is superior and posterior to it, and the ramus of the pubis, which is external to it, dividing at the subpubic ligament into its two terminal branches.

Anomalies.—Cases sometimes occur where the common trunk of

the sciatic and pudic, will pass out of the pelvis, before bifurcating; but these are very rare. The most important anomaly in this vessel is however, where it terminates either in the long perinæal, or in the artery of the bulb, as in that case an accessory branch is detached, either from the deep epigastric or from external iliac, or from the obturator, prior to its emerging from the thyroid foramen; this passes downwards and backwards, on either side of the membranous portion of the urethra, and then, piercing the triangular ligament, pursues the normal course, and throws off branches corresponding to those of the true pudic; or such abnormal branch may occasionally occupy a still more dangerous position, by running along the sides of the prostate—a perilous situation to the lithotomist. During the course of a former session, we had an opportunity of observing a very curious variety: the obturator artery sprang abnormally from the epigastric, and immediately after its origin threw off a very large branch, which perforated the transversalis fascia, and emerging through the external abdominal ring, descended on the front of the pubis, and became the dorsal artery of the penis.

Collateral Branches of the Pudic.—In its first stage, generally a few small twigs to the neck of the bladder; in its second, none; and in its third, from behind forwards; 1. Inferior hæmorrhoidal; 2. Transverse perinæal; 3. Long perinæal; 4. Artery of the bulb; 5. Artery of the cavernous structure; and 6. Dorsal artery of the penis.

1. Inferior Hæmorrhoidal.—Generally two or three small twigs, which arise from the pudic, at the commencement of its third stage; they pierce the obturator fascia, cross the ischio-rectal fossa, through the fat of this region, and are distributed to the verge of the anus, anastomosing with the superior, and middle hæmorrhoidal.

2. Transverse Perinæal.—A short, thick trunk, which arises a little external to the last; it perforates the obturator fascia and base of triangular ligament, runs inwards and forwards, at first behind, then below, and ultimately in front, of the transverse perinæal muscle, reaches the accelerator urinæ, which it supplies, and anastomoses with its fellow of the opposite side.

3. Long Perinæal.—Longer, but smaller in calibre than the last, in common with which it usually arises; it also pierces the obturator fascia, and base of triangular ligament, and, running upwards, forwards, and inwards, through the ischio-bulbar space, between the erector penis and accelerator urinæ, reaches the root of the scrotum, where it divides into two branches—an internal, which supplies the septum scroti, and communicates with its fellow of the opposite side; and an external, which ramifies on the outside of the scrotum, and anastomoses with the superficial pudic of the femoral.

4. Artery of the Bulb.—Arises from the pudic, as that vessel lies between the layers of the triangular ligament; it passes upwards and inwards, anterior and inferior to Guthrie's muscle, and before reaching the urethra, divides into two branches—bulbar, and glandular; the former, the larger, pierces the anterior layer of the triangular ligament, and reaches the bulb, to the substance of which, and the spongy structure of the urethra, it is distributed; while the latter, much the smaller, supplies Cowper's glands. The artery of the bulb, while between the layers of the triangular ligament, lies about half an inch above its base.

Anomalies.—This artery may be sometimes double, and occasionally takes a very peculiar course to reach its destination; as it runs at first from its origin directly inwards, towards the mesial line along the lower edge of the triangular ligament, and then ascends almost vertically to the urethra. Under these circumstances, it always arises about half an inch posteriorly to its ordinary position.

5. Artery of the Cavernous Structure, arises opposite the subpubic ligament, in company with the dorsal artery of the penis; it perforates the crus penis on its internal and inferior wall, and runs through the cellular structure of the corpus cavernosum penis, but separated from its fellow of the opposite side by the septum pectiniforme, on the lower edge of which it lies; it communicates frequently with it through the teeth of the septum, and gives off numerous capillary branches for the nutrition of the organ, as well as others which terminate in the venous cells, of which it is principally composed. (See Anatomy of the Penis.)

6. Dorsal Branch, arises in company with the last, and winds upwards and forwards, between the crus externally and the bulb internally, then between the true suspensory ligaments of the penis, along the dorsum of which it runs forwards, between its corresponding nerve, which is on the outside, and vein, which is to its inside, till it arrives at the corona glandis; here it sinks deeply, and forms, between the truncated extremity of the corpora cavernosa and glans penis, a plexus from which numerous filaments are detached to supply the structure of the glans. The dorsal artery, about the middle of the penis, always throws off a large cutaneous branch, which is distributed to the integument of that organ, and to the side of the scrotum.

EXTERNAL ILIAC.

Arises from the common, internal but opposite to the sacro-iliac synchondrosis, and passing downwards, forwards, and outwards, terminates in the femoral at the pectineal line, a little internal to the pectineal eminence.

Relations.—Anteriorly, peritonæum, Abernethy's or expansion of fascia iliaca, ureter above, and vas deferens below, one of the internal circumflex ilii veins, and genito-crural nerve ; posteriorly, fascia iliaca, psoas muscle, accessory obturator nerve, and the other external circumflex ilii vein ; externally, anterior crural nerve, but separated from it by some fibres of the psoas and fascia iliaca ; and internally, its own vein below, but on a plane posterior and internal to it above.

Remarks.—We have omitted the spermatic vessels, as an anterior relation for this artery, although they do occasionally lie over it near its termination ; but we believe that, as the rule, they are generally external to it. The anterior crural nerve also, although external to the iliac artery in its whole course, is nevertheless much farther from it above than below ; being in the former instance, fully an inch distant from it ; but in the latter, only about a quarter of an inch.

Anomalies.—The only one which we are acquainted with, is where the external iliac bifurcates into the femoral and profunda, in some part of the iliac fossa.

Collateral Branches.—1. Deep epigastric, and 2. Internal circumflex ilii.

1. Deep Epigastric.—A rather large branch, arising from the external iliac, a line or two above Poupart's ligament ; it passes at first downwards and inwards, then upwards, forwards, and inwards, entering the posterior part of the sheath of the rectus, beneath the semilunar margin of the internal oblique and transversalis, and, ascending as high as the umbilicus, breaks up into a series of branches, which anastomose with the internal mammary, superficial epigastric, and lumbar.

Relations.—Anteriorly, transversalis fascia, spermatic cord, and abdominal muscles ; posteriorly, external iliac vein, peritonæum, and posterior wall of sheath of the rectus ; externally, internal abdominal ring, and spermatic artery, which separates it from the vas deferens ; and internally, obliterated hypogastric artery.

Remarks.—This vessel, in its course upwards, lies very close to the internal abdominal ring, and, according to our observations, invariably runs between the layers of the transversalis fascia, one layer of which, thin but strong, always separates it from the peritonæum.

Anomalies.—The epigastric may arise from the obturator, or internal circumflex ; it may also be double, and in that case one branch has been seen to pass external and the other internal to the cord as it emerges through the internal ring. Again, it has been observed to wind at first behind the external iliac vein, and then to ascend in its usual course. Cases are recorded, where this artery has been seen to spring from the iliac, two inches and a half above Poupart's ligament.

Collateral Branches.—A few twigs only, and of no importance; but sometimes a large branch runs directly inwards, behind the origin of the rectus, sending down filaments to anastomose with the obturator, and others to communicate with its fellow of the opposite side. It also, at the internal ring, gives off the cremasteric branch, which ramifies in the substance of the cord, and ultimately anastomoses, in the scrotum, with the spermatic and deferential arteries.

II. INTERNAL CIRCUMFLEX ILII.

Arises from the external iliac, close to the origin of the epigastric; it passes upwards and outwards, parallel to but above Poupart's ligament, crossing over the anterior crural nerve, and lying between the fasciæ transversalis and iliaca, where a well-marked white line indicates its course. On reaching the anterior superior spine of the ilium, it anastomoses with the ilio-lumbar, superficial circumflex of the femoral, and profunda division of the glutæal; it next continues its course backwards, on the crest of the ilium, between the internal oblique and transversalis, and over the ilio-scrotal nerve, to the back part of the crest, where it again communicates with the superficial glutæal and ilio-lumbar; and ultimately turns upwards, between the same muscles towards the last rib, to anastomose with the lumbar and with the intercostals.

Anomalies.—This artery may arise either from the obturator, or deep epigastric; and both it and the latter vessel have been known to spring from the external iliac, two inches or more above Poupart's ligament; this, however, is very rare. We have observed, in one case only, a most important anomaly with respect to the origin of this artery, where it sprang from the epigastric, above the internal abdominal ring, and, crossing above the cord as it emerged from the abdominal cavity, passed outwards, to reach its proper destination. In an operation for oblique inguinal hernia, strangulated at this orifice, it would have been impossible that the vessel could have escaped.

ARTERIES OF THE LOWER EXTREMITY.

FEMORAL ARTERY.

The *Femoral Artery*, the continuation of the external iliac, commences opposite the pectineal line, and passing downwards, backwards, and inwards, terminates at the junction of the lower with the middle third of the thigh, where it perforates the adductor magnus, and becomes the poplitæal. We will accordingly examine it as it lies in the upper third of the thigh, or Scarpa's space, and in the middle third, or Hunter's canal.

Relations—First Stage, or Scarpa's Space.—Anteriorly, integument, superficial fascia, with lymphatic glands, fascia lata, crural branch of genito-crural nerve, and sartorius; posteriorly, psoas muscle, which separates it from the capsular ligament of the hip-joint, pectinæus, adductor brevis (but with the interposition of the profunda and femoral arteries), profunda, and external circumflex veins, communicating branch between internal saphenus and obturator nerves, some loose areolar tissue, and ultimately the adductor longus; externally, anterior crural nerve above, and edge of sartorius below; and internally, its own vein superiorly, and the adductor longus inferiorly.

Relations—Second Stage, or Hunter's Canal.—Anteriorly, sartorius, and strong aponeurosis, the latter stretched in inverted arches between the vastus internus and adductores longus and magnus, and internal saphenus nerve; posteriorly, the conjoined tendons of the adductors, vastus internus, and femoral vein; internally, the adductores longus and magnus; and externally, the vastus internus.

Remarks.—As it is a matter of some importance, to define the point where the femoral artery emerges from beneath Poupart's ligament, it may be stated, as a general rule, that it crosses under it, about two inches and a half from the spine of the pubis, and three from the anterior superior spine of the ilium. In a well-formed man, when in the upright position, if a plumb-line be allowed to fall from this point perpendicularly downwards, it will very nearly map out the course of the vessel,—the plumb-line will be, however, slightly external and posterior to it, as it is the twist in the femur that gives the apparently very great curve to the artery. On examining its relative position with regard to its vein, we will find, that immediately below Poupart's ligament the vein lies directly internal to it, but as they continue to descend, the vein gradually inclines behind it, so as to lie completely posterior to it, in the middle of Hunter's canal, and slightly external as it passes from that canal into the popliteal region. The student should also remember, that although the insertions of the pectinæus and adductor brevis are given as posterior relations for the artery, in the usual condition of the limb, yet they are really at some distance from it, and the thigh must be forcibly rotated outwards before they can be brought in close proximity with the vessel, and under all circumstances, a very small portion indeed of the adductor brevis—in fact, only that part intercepted between the pectinæus and adductor longus, which is always exceedingly small, lies behind it. As Scarpa's space or angle, and Hunter's canal, are invested with great importance,—the former from its practical utility in a surgical point of view, and the latter from the historical associations connected with it,—we consider it necessary to give in

detail the several boundaries of each. When the integuments and investing fascia have been removed from the upper part of the thigh, the region described by Scarpa will be exposed : it represents in figure a scalenous triangle, its external and longest leg formed by the sartorius ; its internal, by the adductor longus; its base, by Poupart's ligament ; and its floor, by the edge of the rectus, psoas, and iliacus, pectinæus, and adductor brevis. The three important parts which it contains are,—the anterior crural nerve, most externally ; the femoral artery in the middle ; and its vein, most internally ; and, in addition, but of less note, the superficial epigastric, circumflex ilii, pudic, profunda, and internal and external circumflex, and two superior perforating arteries, with the accompanying veins of those vessels. Hunter's canal on the other hand, forms a hollow prism, but broader above than below ; it occupies the middle third of the thigh, and is bounded externally, by the vastus internus ; internally, by the adductores longus and magnus ; posteriorly, by the conjoined tendons of these muscles at their insertion into the linea aspera ; and anteriorly, by a strong aponeurosis, on which the sartorius rests ; here the artery occupies a middle position between the internal saphenous nerve, which lies at first external to it, then anterior, and ultimately internal ; and the femoral vein, which is at first posterior and internal, then directly behind it, and ultimately, posterior and slightly external to it ; the anastomotica magna artery, is also found in this canal.

Anomalies.—The femoral artery is generally very regular in its course ; but some few cases are on record, where it has been double, and also where the two branches, after continuing separate for some distance, again united to form a single trunk.

Collateral Branches.—In Scarpa's space, i, superficial pudic ; ii, circumflex ilii ; iii, epigastric ; and iv, profunda ; in Hunter's canal, v, several muscular, from its inner side ; and vi, anastomotica magna.

I. SUPERFICIAL PUDIC.

Usually very small ; arising from the femoral, about three quarters of an inch below Poupart's ligament ; it passes at first directly inwards, for a short distance, and then divides into two branches —a superficial, which pierces the pubic portion of the fascia lata, and runs upwards and inwards, between the layers of the superficial fascia to the front of the symphysis pubis, supplying that region, and anastomosing with its fellow of the opposite side ; and a deep branch, which continues beneath the fascia lata, as far as the side of the scrotum, where it becomes cutaneous, supplying the scrotum, and anastomosing with the perinæal division of the deep pudic ; in the female, it is distributed to the labia majora.

II. SUPERFICIAL CIRCUMFLEX ILII.

Also small; it arises from the external side of the femoral, nearly at the same point with the preceding; perforates the iliac portion of the fascia lata, sometimes the cribriform, and runs upwards and outwards, parallel but inferior to Poupart's ligament, to the anterior superior spine of the ilium, where it communicates with the internal circumflex, ilio-lumbar, and glutæal.

III. SUPERFICIAL EPIGASTRIC.

Larger than either of the two preceding; it perforates the cribriform process of the fascia lata, and running upwards and inwards, over Poupart's ligament, invested in the layers of the superficial fascia, anastomoses at the umbilicus, with the deep epigastric, and internal mammary.

Remarks.—These three vessels may arise by a common trunk, and they all pierce the anterior part of the sheath of the femoral vessels.

IV. PROFUNDA.

Always very large; sometimes even equal in size to the femoral, from the outer and back part of which it arises; it passes at first downwards and outwards, then downwards and inwards, winding beneath its parent trunk, then perforates the adductor magnus, opposite the middle third of the thigh, and at last runs outwards and downwards, to terminate within the biceps, by anastomosing with the muscular branches of the poplitæal.

Relations.—Anteriorly, it is at first slightly overlapped by the femoral artery, then by integument, superficial and deep fasciæ, then by the edge of the rectus and sartorius, again by the femoral artery, but separated from its own vein and the femoral, and external circumflex ilii veins, with the obdurator saphenous nerve, and insertion of the adductor longus; posteriorly, it lies in succession from above downwards on the tendons of the psoas and iliacus, cruræus, edge of vastus internus, insertions of pectinæus, and adductores brevis and magnus.

Anomalies are only those of origin, as it may arise in common with the femoral, from the external iliac; or, if from the femoral, it may spring from that vessel, either one, two, three, or four inches below Poupart's ligament; but instances are very rare, indeed, where its origin ever exceeds two inches below the point last mentioned.

Collateral Branches of Profunda.—1. External, and; 2. Internal circumflex ilii; and 3. Perforating arteries.

1. External Circumflex.—Always a large branch, arising from

the profunda immediately after its origin from the femoral; it passes outwards, between the branches of the anterior crural nerve, over the tendons of the psoas, iliacus, and cruræus, and under the sartorius, and rectus, and divides into three branches,—ascending, middle, and descending. Of these, the ascending runs upwards and outwards, and reaches a fusiform space, filled with loose areolar tissue; bounded in front, by the sartorius; externally, by the tensor vaginæ femoris; behind, by the edge of the glutæus medius and great trochanter, and internally, by the iliacus internus; at the anterior inferior spine it anastomoses with the profunda division of the glutæal. The middle, which in direction appears to be the continuation of the external circumflex, insinuates itself, first between the cruræus and vastus externus, then between the latter muscle and the bone, until it reaches the linea aspera, where it pierces the attachments of the glutæus maximus, and anastomoses with a similar branch of the internal circumflex ilii. The descending branch runs at first downwards and outwards, between the rectus and cruræus, sending several long branches to both, then descends along the outside of the thigh between the rectus, which is in front of it, the cruræus which is behind it, and the vastus externus, which is to its outside, and becoming subfascial about two inches above the knee, runs downwards, to the upper and outer part of the patella, to anastomose with the superior external articular artery.

2. INTERNAL CIRCUMFLEX.—Larger than the external, but close to which it usually arises; it passes at first directly backwards, between the tendons of the psoas and inner edge of the pectinæus, and divides into two branches,—an ascending, which passes upwards and backwards, on the obturator externus, enters the digital fossa, and anastomoses with the obturator, sciatic, and glutæal; and a descending, which runs directly backwards, to the posterior surface of the bone, between the obturator externus and adductor brevis, and then between the adductor magnus and quadratus femoris, to communicate with a similar branch from the external, and with the glutæal, sciatic, and first perforating artery. The internal circumflex always gives off a branch to supply the joint, and while in the triangular space, behind the pectinæus, anastomoses very freely with the obturator.

Anomalies.—Both circumflex may spring by a common trunk, or, where the profunda arises some distance below Poupart's ligament, both may take their origin from the femoral, or one from it, and the other from the profunda.

3. PERFORATING ARTERIES, are three in number, all arising from the posterior wall of the profunda; the first, passes backwards, usually between the pectinæus and adductor brevis, and then through

the adductor magnus; the second, always perforates the adductor brevis, and then the adductor magnus; while the third, pierces the latter muscle only; lying now under the hamstring muscles, they freely supply the great sciatic nerve, and the areolar tissue in which it is imbedded, and divide each into two branches, which anastomose with each other, and likewise communicate above with the sciatic and glutæal, and below with branches of the poplitæal, thus establishing an important chain of inosculation, which is beautifully displayed in ligature of the femoral artery, when their calibre becomes gradually augmented to that of the radial.

V. MUSCULAR.

Several very large branches for the supply of the muscles in the immediate vicinity of Hunter's canal.

VI. ANASTOMOTICA MAGNA.

The only branch in Hunter's canal which has received a name; it arises from the inner and anterior side of the femoral, at the lower part of the this canal, and runs downwards and inwards, on the upper edge of the adductor magnus tendon, in company with the internal saphenous nerve; at first beneath the aponeurosis which connects it to the vastus internus, but soon perforating it, and dividing into two sets of branches—an anterior, which passes forwards and outwards, to anastomose with the superior internal articular artery; and a posterior, which winds backwards, into the *poplitæal space* to communicate with the collateral branches of that vessel.

The femoral artery enters this space, through an oval opening, the long measurement of which is from above downwards, and situated really in the tendon of the adductor magnus, but because two other muscles are in some degree connected with its margins, it is usually described as having these boundaries :—Superiorly, tendons of adductores magnus and longus; inferiorly, those of the adductor magnus and vastus internus; internally, adductor magnus; and externally, vastus internus. This aperture is much too large for the artery and its vein, and here the sheath which invested them, and which is continued downwards from Poupart's ligament, formed in front by a process from the fascia transversalis, and behind by that of the fascia iliaca, ceases to exist, or at least is so indistinct, that beyond this point it becomes incapable of demonstration.

POPLITÆAL ARTERY.

The direct continuation of the femoral, commences at the opening of the adductor magnus, and passing downwards and slightly inwards, terminates at the lower margin of the poplitæus muscle.

Relations.—It is covered at first, for about an inch, by the semimembranosus, then by a quantity of fat and areolar tissue, the poplitæal nerve and vein, and the approximation of the two heads of the gastrocnemius ; and it is supported by the flat surface of the back of the femur, from which it is separated by a cushion of fat, by the ligamentum posticum of the knee-joint, a lymphatic gland generally intervening, and ultimately by the poplitæus.

Remarks.—The POPLITEAL SPACE, which this vessel occupies, is also one of great surgical importance ; it may be exposed by stripping the integuments from the lower third of the back part of the thigh, and to the same extent on the posterior surface of the leg. The superficial fascia, which lies beneath the integument is thin, especially on the sides of the space, but becomes more dense towards its middle, and in it are found branches of the posterior cutaneous nerve from the sacral plexus, with the posterior or external saphenous vein. On removing these parts, the true poplitæal fascia is exposed, stretched tensely across the space, its fibres forming well-marked curves, the concavities of which are directed upwards and outwards; opposite the flexure of the joint it is remarkably strong, and is here perforated by the saphenous vein, in its course to join the poplitæal. When this fascia is removed, the outline of the space is exposed ; it is of a diamond shape, or perhaps it might more properly be said to consist of two triangles, with their bases united opposite the condyles, the superior being the better defined, and so much larger, as to be capable of embracing by its expanded legs those of the inferior at their point of junction. The outer wall of the poplitæal region is formed above by the tendon of the biceps, and below by the external head of the gastrocnemius, soleus, and plantaris ; while the inner is constituted by the semitendinosus, semimembranosus, gracilis, and sartorius above, and by the inner head of the gastrocnemius below. With respect to the parts which it contains, on removing the fat, which completely fills it up, we will find the poplitæal nerve to be the most superficial, being at first external to the vessels, but crossing posterior to them, opposite the flexure of the joint, becoming internal to them below ; the vein holds nearly the same relation to the artery, being at first a little external, then superficial, and ultimately slightly internal, to it ; but it must be recollected, that both the vein and the artery, are here intimately connected to each other, by condensed areolar tissue. Three or four

lymphatic glands are always found opposite the joint, generally surrounding the vessels.

Anomalies.—Extremely rare, but it is sometimes found double, and it may divide into its terminal branches, the anterior and posterior tibials, either on or above the poplitæus muscle.

Collateral Branches.—1, Superior external; 2, superior internal; 3, inferior external; 4, inferior internal; 5, azygos articular; and 6, sural.

I. SUPERIOR EXTERNAL ARTICULAR.

Rather large, arising from the outer side of the poplitæal, opposite the external condyle; passes outwards, and slightly upwards, resting on the bone, beneath the poplitæal vein and nerve, tendon of the biceps, and peronæal nerve. Beneath the vastus externus, it divides into two branches—a superficial, which, piercing that muscle, runs to the superior external angle of the patella, to anastomose with the descending branches of the external cicumflex of the profunda, and the adjacent articular; and a deep, which, on the front of the femur, above the condyles, forms an arch with a similar branch from the internal, for the supply of the synovial membrane.

II. SUPERIOR INTERNAL ARTICULAR,

Arises, opposite the last, from the inner side of the poplitæal; it runs upwards and inwards, likewise on the bone, beneath the tendons of the semitendinosus, semimembranosus, gracilis, sartorius, and adductor magnus, and on arriving beneath the vastus internus, divides into two branches—a superficial, which runs to the upper and inner side of the patella, to anastomose with the anastomotica magna, and adjoining articular; and a deep, which proceeds to supply the joint.

III. INFERIOR EXTERNAL ARTICULAR,

Arises exactly opposite the articulation; it winds outwards over the tendon of the poplitæus, and external semilunar cartilage, and beneath the external head of the gastrocnemius, plantaris, biceps, external lateral ligament, and peronæal nerve; and, reaching the front of the joint, divides into two branches—a superficial, which runs to the front of the patella to anastomose with the anterior tibial recurrent, and its fellow of the opposite side; and a deep, to supply the interior of the articulation.

IV. INFERIOR INTERNAL ARTICULAR.

This arises a little lower than the last, and passes downwards and inwards, along the upper margin of the poplitæus, resting on the back part of the tibia, and under the internal head of the gastrocnemius, tendons of semitendinosus, gracilis, sartorius, and expansion from internal lateral ligament; and on the front of the joint also divides into two branches—a deep, to supply its interior; and a superficial, to anastomose with its fellow, and with the anterior tibial recurrent.

V. AZYGOS ARTICULAR.

Always small; it pierces the ligament of Winslow, and, entering the joint, is distributed to the crucial ligaments.

VI. SURAL.

Long slender branches, irregular as to number; they spring from the superficial surface of the poplitæal, and, passing downwards, are principally distributed to the muscles on the back of the leg.

Remarks.—The branches of the poplitæal, are very variable both in origin and size, but where those of one side are found to be small, those of the other are always proportionally large. The point where it most usually divides into anterior and posterior tibial, is at the lower margin of the poplitæus; but this rule, as we have already stated, is liable to many variations.

POSTERIOR TIBIAL.

Is the direct continuation of the poplitæal, both in size and direction. It arises opposite to the lower edge of the poplitæus, and, passing downwards and inwards, terminates by dividing into the external and internal plantar arteries, between the internal malleolus and os calcis, and likewise between the two heads of origin of the abductor pollicis.

Relations.—It is covered by the gastrocnemius, soleus, plantaris, deep fascia, and posterior tibial nerve; and it rests on the tibialis posticus, flexor digitorum communis, and lower and back part of tibia, from which it is separated by a cushion of fat.

Remarks.—Much importance has been latterly attributed to the tendinous arch between the two heads of the soleus, beneath which the artery glides to reach the posterior part of the leg. Its obvious use appears to be, to prevent compression of the vessel from the contraction of the muscle, and it can always be easily shown by

cutting across the tendo Achillis, and then dissecting up the superficial from the deep muscles. The posterior tibial nerve lies to the inside of the artery at its origin, but it crosses behind it at the junction of its superior and middle thirds, so as to become external to it. In its inferior third, where it is most frequently the subject of operation, the artery is comparatively superficial, but in order to reach it, it will be necessary to cut through—1, integument; 2, superficial fascia; 3, a thin aponeurosis from the inner edge of the tendo Achillis; 4, deep fascia, which is here dense and strong, its fibres running tranversely across from tibia to fibula; and 5, expansion from the sheath of the tendon of the flexor pollicis. The order of parts from within and before, backwards and outwards, at this point, is—1, tibialis posticus; 2, flexor communis; 3, artery, with a vein on either side; 4, posterior tibial nerve; and 5, flexor pollicis longus.

Anomalies.—We have already observed that the posterior tibial may arise at any point above the poplitæus, or even a short distance below it; while in some instances, it is said to be altogether absent, but of this we have never observed even a solitary example; in many cases, undoubtedly, it existed only as a mere filament, but the peronæal under these circumstances was abnormally large, and gave off the ordinary branches of the tibial.

Collateral Branches.—1. Peronæal; 2. Several branches to the adjacent muscles; 3. Internal; and 4. External plantar.

1. Peronæal.—Always a large branch, arising from the outer side of the posterior tibial, an inch and a half below the inferior margin of the poplitæus; it passes at first downwards and outwards, under the deep fascia, and on the tibialis posticus; then beneath the flexor pollicis longus, having the fibula external to it, till it arrives about two inches above the ankle-joint, where it divides into anterior and posterior fibular; the former, pierces the interosseous ligament, and runs downwards to the external malleolus, in front of the fibula, and under the peronæus anticus; while the latter, passes on the back of the fibula, still beneath the flexor pollicis longus, and beneath the external malleolus forms an anastomotic loop with the anterior, where they also communicate with the tarsal and metatarsal branches from the anterior tibial.

Anomalies.—This artery may arise either independently from the popliteal or from a line to two inches below the margin of the poplitæus. In some cases it is so very small that it can scarcely be said to exist at all, while in others it may be vastly increased in calibre: under the latter circumstances, it may terminate either by reinforcing the posterior tibial by a cross branch, which will run transversely inwards, to join it an inch or two above the ankle-joint, its course

being either superficial to, or deeper than, the tendons on the back of the leg; or it may send through the interosseous space, a very large branch, which will take the place of the anterior tibial, the latter vessel being in such case abnormally small, and terminating before it reaches the anterior annular ligament.

II. MUSCULAR.

Several long branches, distributed to the deep muscles of the leg.

III. INTERNAL PLANTAR.

One of the terminal branches of the posterior tibial, and small as contrasted with the external; it arises between the os calcis and internal malleolus, and passes forwards and inwards, between the two heads of the abductor pollicis, then between it and the external head of the flexor pollicis brevis, and, reaching the space between the first and second metatarsal bones, divides into two branches—an internal, which crosses obliquely forwards and inwards, to the inner side of the great toe; and an external, which, on arriving at the cleft between the first and second toes, subdivides, and supplies their adjacent surfaces; it is distributed only to the skin of those parts.

IV. EXTERNAL PLANTAR.

Always very large, arising in common with the preceding; it passes at first forwards and outwards, between the musculus accessorius, flexor communis, and flexor pollicis, which are above it, and the flexor digitorum brevis, which is below it; then runs directly forwards, for about an inch, between the abductor minimi digiti on the outside, and the flexor digitorum brevis on the inside, being here very superficial, and, arriving at the base of the metatarsal bone of the little toe, is abruptly inflected inwards and forwards, as far as the first interosseous space, where it terminates by anastomosing with the perforating branch of the dorsalis pedis, thus forming the *deep plantar arch.* In this latter part of its course, its relations are the following:—Below it, three layers of the plantar muscles; above it, the interossei, and bases of the metatarsal bones; anterior to it, the transversalis pedis; posterior and internal to it, the adductor pollicis; and external to it, the flexor brevis minimi digiti. The plantar arch gives off four digital branches from its convexity, which is turned forwards; and from its superior wall three, which are termed interosseous; the first digital branch, passes forwards and outwards, and is distributed to the outside of the little toe; the second, runs

to the cleft between the fifth and fourth toes, and bifurcates for the supply of their adjacent surfaces; the third, proceeds to the space between the third and fourth, where it also divides for their opposed sides; while the fourth, runs in a similar manner to the interval between the second and third, and there divides for the supply of their approximated sides; all these digital branches, with their corresponding nerves, run close to the sheaths of the flexor tendons, to which they are bound by looped processes of the plantar fascia, and they observe an arrangement similar to those of the fingers, forming arches on the last, or ungual, phalanges for the supply of the integuments and of the matrix of the nails. The interosseous branches, which are three in number, are only found in the three external interosseal spaces; they perforate and supply those muscles, and anastomose with the dorsal interosseous branches from the metatarsal of the anterior tibial.

Remarks.—Those arteries, but especially the external plantar, supply numerous branches to the fat and muscles of this region, with several filaments to the articulations, and, as the general rule, they lie deeper than their corresponding nerves.

ANTERIOR TIBIAL.

Arises in common with the posterior, from the poplitæal, but is much smaller in size; it passes directly forwards, through a quadrilateral space, bounded above, by the edge of the poplitæus, and tibio-fibular articulation; below, by the upper margin of the interosseous ligament; and on either side, by the tibia and fibula; and is accompanied by its two venæ comites, by the communicating branch between the anterior and posterior tibial nerves, and by a few fibres of the tibialis posticus. On reaching the anterior aspect of the leg, it runs almost vertically downwards, as far as the annular ligament, where it terminates in the dorsalis pedis.

Relations.—It lies at first, between the tibialis anticus and extensor communis, then between the tibialis anticus and extensor pollicis longus, and lastly, between the extensor pollicis and extensor communis, passing with the tendon of the former beneath the annular ligament. The anterior tibial nerve, a branch of the peronæal, is in company with it, being at first external to it; a little below the middle of the leg, is immediately over it; and below ,internal to it.

Remarks.—This artery is very deeply situated at its commencement, but near its termination becomes comparatively superficial.

Anomalies.—In case of this vessel arising high up in the poplitæal space, it may run to its destination, either under or through the poplitæus muscle. Where it is of less than the normal size, it will

usually be found to terminate at the ankle joint, the anterior peronæal taking its place; or where it is larger than ordinary, it may usurp the position of the latter, and likewise, as the dorsalis pedis, compensate by its anastomosis with the external plantar for a deficiency of calibre in this latter vessel.

Collateral Branches.—1. Anterior tibial recurrent; 2. Muscular; 3. Internal; and 4. External malleolar.

I. ANTERIOR TIBIAL RECURRENT.

Comparatively large; arising from the anterior tibial, just as it emerges on the front of the leg; it passes upwards and forwards, through the fibres of the tibialis anticus, and communicates with both the inferior articular.

II. MUSCULAR.

Very numerous, but small, supplying the adjacent muscles, as the parent trunk glides between them.

III. INTERNAL MALLEOLAR

Arises from the anterior tibial, beneath the annular ligament; it passes inwards, resting on the tibia, and beneath the tendons of the extensor pollicis and tibialis anticus. It anastomoses with branches from the internal plantar, and supplies the parts in that region.

IV. EXTERNAL MALLEOLAR.

Larger than the last, close to which it arises; it passes outwards over the fibula, and under the tendons of the extensor communis and peronæus anticus, and anastomoses with the peronæal, tarsal, and metatarsal.

DORSALIS PEDIS.

The continuation of the anterior tibial; it runs downwards and inwards, over the dorsum of the foot between the extensor pollicis which is internal to it, and the inner tendon of the extensor communis, which is external to it, and covered only by the integuments and fascia, and crossed by the inner tendon of the extensor brevis. On reaching the base of the metatarsal bone of the great toe, it divides into its terminal branches.

Collateral Branches.—i. Tarsal, ii. metatarsal, iii. communicating, and iv. princeps pollicis.

I. TARSAL.

Generally a small branch, arising immediately below the annular

ligament; it passes outwards and forwards, beneath the extensor brevis, supplying it and the structures of the dorsum of the foot, and ultimately bending backwards and outwards, terminates at the external malleolus, by anastomosing with the malleolar, peronæal, and metatarsal.

II. METATARSAL.

Larger than the tarsal, below which it arises; it also bends downwards and outwards, beneath the common extensor tendons, and then, arching backwards and outwards, terminates at the external malleolus by communicating with the peronæal and tarsal; from the convexity of the arch, which is directed towards the toes, four digital branches are given off, which, bifurcating at the clefts between each pair of the four outer toes, supply their adjacent sides; while three interosseous branches are detached from it inferiorly, to supply the interosseous muscles, and to anastomose with similar twigs from the deep plantar arch.

III. COMMUNICATING BRANCH.

In size, may be considered, the true termination of the dorsalis pedis; it comes off in common with the princeps pollicis, and piercing the first interosseous spaces, inosculates with the external plantar, to form the deep plantar arch.

IV. PRINCEPS POLLICIS.

Arises in common with the the last, and runs downwards and forwards, along the first interosseous space, where it is crossed by the inner tendon of the extensor brevis. It divides into two branches, an internal, which is distributed to the inner side of the great toe; while the external, subdividing, supplies the opposed surfaces of the great and second toes.

Remarks.—The supply of the toes, may be thus briefly recapitulated: the muscular structure of the three outer toes and a half, is supplied by the deep plantar arch; while that of the great toe, and half the second, receives its nutrition from the dorsalis pedis; but the integument of the three outer toes and a half, is supplied by the metatarsal branch of the dorsalis pedis, while to the skin of the inner toe, and half the second, the internal plantar artery is distributed. Hence it may be observed, that a very close analogy exists in the distribution of the vessels of the lower and upper extremities, the anterior tibial representing the radial, and the posterior, the ulnar.

VENOUS SYSTEM.

For the purpose of examining the veins, they should be injected from the ultimate branches, in the direction of the heart; but as these vessels are usually found distended with blood after death, the larger branches are sufficiently evident for the purpose of the anatomist; but if it is an object to follow the osseal venous networks, or the minute radicles and plexuses of organs, their artificial distension becomes absolutely indispensable. The veins are divisible into the general and portal systems, whilst the former may again be subdivided into thoracic, cervico-cephalic, brachial, abdominal, femoral, and rachidian.

From the course pursued by the circulatory system, the description of the veins might be commenced at any point that would be most convenient, and again traced back to the same place; but experience has taught us, that it is always better to assume the termination of the arteries in the capillary system, as the starting point; as by this means, the student can more fully comprehend the course pursued by each order of vessels, and the object which each is destined to accomplish in the animal economy. We will therefore commence with the veins of the foot, and first carry them up to the central organ of the circulation.

Plantar Veins occupy the sole of the foot, and are divided into external and internal, the former being the larger of the two; they follow the course of the corresponding arteries, and open posteriorly into the venæ comites of the posterior tibial artery. The external plantar, is nearly four times larger than the internal, and it receives all the muscular branches from the sole of the foot, while both are the efferent vessels of the deep plantar venous plexuses.

Posterior Tibial Veins are two in number, lying one on either side of the corresponding artery, and frequently communicating with each other, by cross branches. We have seen but one vein accompanying this vessel, and in the case it received the peronæal vein three inches above the ankle-joint; we have also observed the posterior tibial veins leaving the artery about the middle of the leg, and passing beneath the margin of the flexor pollicis to join the peronæal, the posterior tibial artery not having any accompanying vein from the point mentioned, until it arrived at the lower margin of the poplitæus.

Peronal Vein accompanies the peronæal artery, and is double, like the last, but much larger, in consequence of receiving all the muscular branches from the posterior and external part of the leg. They communicate with the poplitæal, and when laid open present a cribriform appearance, owing to the number of muscular branches that separately open into them.

Anterior Tibial Vein.—Also double; they accompany their corresponding artery, and passing through the interosseous space, terminate in the poplitæal.

POPLITÆAL VEIN

Commences about half-an-inch above the lower edge of the popliteus, or sometimes at the inferior margin of that muscle, the poplitæal, or main artery of the limb, is for the first time accompanied by a single vein—the poplitæal, which is formed by the union of the anterior and posterior tibial and peronæal veins, all of which however, unite into single trunks prior to their confluence; the poplitæal vein is situated at first posterior and internal to its artery, but in the middle of the space lies directly posterior to it, and is, superiorly, posterior and external to it; at the oval opening in the adductor magnus, their relations to each other are well seen, when both vein and artery have been injected. The poplitæal vein is very intimately connected to its artery a little below the middle of the poplitæal space,; and inferiorly it always seems flattened, on account of the peculiar manner in which the sural veins join it; its coats are thick, and extremely resisting.

Collateral Branches.—1, posterior saphena; 2, articular; and 3, sural.

1. External, or Posterior Saphena, commences at the external extremity of the tarsal arch, and passing upwards and backwards, behind the external malleolus, where it receives the external calcaneal vein; continuing to ascend on the posterior surface of the gastrocnemius, with the crural aponeurosis intervening, and arriving at the middle of the popliteal space, it pierces the fascia, and opens into the posterior and external side of the poplitæal vein, opposite the flexure of the knee-joint. This vein is accompanied, in its upper fourth, by the tibialis communicans, and in the remainder of its course by the posterior saphenous nerve, on which it lies, but separated from it by a layer of fascia; it possesses two valves, one of which is found at its entrance into the poplitæal, and the second corresponding to the upper third of the gastrocnemius; we have met with, however, so many as five valves in this vein. Sometimes this vessel, when it arrives at the poplitæal space, divides into two branches, one of which terminates as usual, sinking between the peronæal and posterior tibial nerves, but always nearer to the latter, in order to reach its destination, while the second curves upwards and inwards, around the inner side of the thigh, to communicate with the internal saphena.

2. Articular Veins follow the course of their corresponding arteries, and open at various points into the poplitæal vein.

3. Sural Veins ascend from the gastrocnemius, between its two heads, and are remarkable for the number of their valves; superior muscular branches from the hamstrings, likewise join them from above.

FEMORAL VEIN

Commences at the oval opening in the triceps and forms the direct continuation of the poplitæal; in Hunter's canal, it lies posterior and external to the artery below; in the middle directly posterior to it, and above, posterior and internal to it; about one inch above its commencement, it receives the venæ comites of the anastomotica magna, and higher up, some muscular twigs; at the apex of Scarpa's space, it continues to hold the same relation to the artery, but from this point it gradually winds upwards and inwards, and at the ilio-pectineal line, lies directly internal to it, being supported in this situation by the pectinæus muscle, or frequently by the bone only, where it joins the external iliac vein. Near the pubis, the vein can be separated from the artery with great ease; but lower down, the union of the two is much more intimate, yet not so much so as that of the poplitæal vein to its corresponding vessel. Professor Porter has remarked, with much truth, that the adhesion of the femoral vein and artery is always increased when poplitæal aneurism exists; and this we have observed in three cases, in one even where the aneurism scarcely exceeded the size of a split walnut. It should be observed that the vein and artery are contained in the same sheath, but at the same time separated from each other, by a septum.

Collateral Branches.—1, anastomotic; 2, muscular; 3, profunda; and 4, internal or anterior saphena.

1. Anastomotic.—Generally two in number, which accompany the artery of the same name, and open into the femoral vein, at the lower part of Hunter's canal.

2. Muscular.—Several large branches, which return the blood from the muscles in the vicinity of the femoral vein, into which they open at various points in its course upwards.

3. Profunda commences by a large branch from the adductor mangus, and receives in succession the veins of the perforating arteries, with some muscular twigs; as it ascends, it lies behind the femoral vein, and ultimately opens into it, about one inch and a half below Poupart's ligament.

4. Internal Saphena.—The longest vein in the body; it commences at the internal extremity of the tarsal arch of veins, and passes upwards and backwards, in front of the internal malleolus,

immediately above which it receives the internal calcaneal vein, which ascends behind the internal malleolus to join it; continuing now its course upwards, and lying over the inner edge of the gastrocnemius, it curves backwards behind the inner condyle of the femur, receiving, just below this point, a communicating branch from the anterior tibial vein, which is remarkable for the number of its valves,—also the internal inferior articular vein; it then passes forwards, over the sartorius, vastus internus, adductores magnus and longus; and while lying over the latter, is joined by the internal and posterior cutaneous veins of the thigh, by which it is increased to double its original size; arriving now at a point about fourteen lines (we have seen it only six) below Poupart's ligament, it curves a little outwards and backwards, and piercing the cribriform fascia and the saphenic opening, from which it receives a tubule, terminates in the internal and anterior part of the femoral vein; while into its curve, the convexity of which looks upwards, the superficial epigastric, circumflex ilii, and pudic veins open. During its whole course, the internal saphena lies in the substance of the superficial fascia, and the valves are from five to seven in number, but in one case we counted nine—six in the femoral portion, and three in the crural. Several communications occur between this vessel and the deep veins—namely, below, with the internal plantar and calcaneal; at the inner condyle of the tibia, with the anterior tibial; above this, with the internal articular; and lastly, with the femoral. As the vein lies over the space between the tendons of the gracilis and sartorius, it is separated from the internal saphenous nerve, which lies beneath it, by the aponeurosis of the sartorius; but at the inner condyle of the tibia, the nerve is at first anterior, then crosses the vein so as to lie posterior to it; and lastly, it becomes anterior again.

EXTERNAL ILIAC VEIN

Commences at the termination of the femoral, on the linea iliopectinea, passes upwards and inwards, and at the shoulder of the sacrum, unites with the internal, to form the common iliac vein. Inferiorly, these veins lie internal to their corresponding arteries; a position which the left maintains throughout its wide course, though near its termination it is on a plane always a little posterior to its corresponding trunk; while the right, during its ascent, gets directly behind its artery; but in a preparation, in our own possession, the latter continues to lie always internal to it. The external iliac veins are supported by the iliac fascia, and the psoæ muscles, and are covered by the peritonæum, and Abernethy's fascia, while

they are crossed by the vasa deferentia, and the epigastric arteries. We have already remarked, that with respect to the venæ comites of the internal circumflex ilii, one generally runs behind, and the other in front of, the external iliac artery, to reach the veins.

Collateral Branches.—Are 1. the deep epigastric, and 2. the internal circumflex ilii.

1. Deep Epigastric.—Always remarkable for their very large size, as they lie one on each side of their corresponding artery; they open into the external iliac vein, about a quarter of an inch above Poupart's ligament.

2. Internal Circumflex Ilii, are also comparatively large, and also double; they sweep downwards and inwards, from the crest of the ilium, receiving at the anterior superior spinous process a large branch from between the layers of the abdominal muscles, and open into the external iliac vein, one branch generally passing behind the external iliac artery, and the other in front of it.

INTERNAL ILIAC VEIN,

Commences at the upper margin of the great sciatic notch, and passing upwards and backwards, terminates at the shoulder of the sacrum, by uniting with the external iliac to form the common iliac trunk. Each vein is from one inch and a half to two inches in length, and both lie on a plane posterior to their corresponding arteries, the right being a little external, and the left internal, to them. This rule is however liable to many deviations, as we have frequently observed those vessels holding the most anomalous relations to each other.

Collateral Branches.—1. Glutæal; 2. Sciatic; 3. Pudic; 4. Obturator; 5. Ilio-lumbar; and 6. Lateral sacral, with all the efferent branches of the pelvic visceral plexuses, consisting of hæmorrhoidal, vesical, prostatic; and in the female, uterine and vaginal.

1. Glutæal may be said simply to open into the commencement of the internal iliac vein, having in its course received the several twigs returning the blood from the various branches given off by its corresponding artery.

2. Sciatic.—Precisely the same remark will apply to this vein, as to the preceding.

3. Pudic.—Is also similar in its course and termination.

4. Obturator.—Its arrangement is likewise the same.

5. IliacLumbar.—Only a very small portion of the blood of this vein is poured into the internal iliac, the remainder being distributed to the rachidian system and lumbar venous loops.

6. Lateral Sacral.—Its distribution is nearly identical with that of the last.

7. Hæmorrhoidal Plexus surrounds the inferior third of the rectum, lying external to the muscular tunic,and supported by the fibrous tubule derived from the lateral vesical ligaments ; it communicates in front with the vesical plexus ; behind, with the middle sacral vein, which connects it with the Rachidian system, and likewise with the deep hæmorrhoidal plexus, which lies beneath the mucous membrane, and is best marked near the anus. From this plexus, the blood is carried off by the superior, middle, and inferior hæmorrhoidal veins ; the first forming the commencement of the inferior mesenteric, and the two latter opening into the internal iliac.

8. Prostatic Plexus.—In order to understand the formation of this plexus properly, it will be necessary to take a short review of the vessels connected with the male organ of coition. When all the superficial coverings have been removed from the dorsum of the penis, the dorsal vein is seen in the groove between the two corpora cavernosa, lying between its artery and nerve, both of which are external to it. This vein, which is sometimes double, but generally single, arises by a series of radicles ramifying between the glans and the blunted extremities of the corpora cavernosa ; when formed, it passes backwards, between those two bodies, perforates the upper part of the triangular ligament, and terminates in the prostatic plexus. In its course backwards, it receives three or four large veins from the interior of the corpora cavernosa, which ascend between the layers of the septum pectiniforme, in order to reach it ; as well as the great integumentary vein of the penis, which commences in the following manner :—Around the free margin of the prepuce, a complicated venous circlet is formed from the capillaries of the superficial dorsal artery, and the blood from it at first is carried back by two veins on either side ; but these coalesce after a short course, and constitute single trunks, which, after an equally brief interval, again unite to form a single vessel, which, running back as far as the subpubic ligament, sinks deeply and joins the dorsal vein, which, as we have already observed, empties itself into the prostatic plexus. Hence it will be seen that the prostatic plexus receives blood not only from its own immediate organ, but likewise a large quantity from the penis and its investing tissues, and this is sufficient to account for the larger size it always presents, even under ordinary circumstances. The pexus lies between the capsule and the gland itself, imbedded in a stroma of condensed areolar tissue, and the veins which compose it are remarkable for the tenuity of their coats, for their alternate dilatations and constrictions, and for their generally engorged condition. They pour their blood, by several long sinuous vessels

which run along the sides of the neck of the bladder, into the vesical plexus.

9. Vesical Plexus.— This extensive and intricate venous plexus, principally derived from the prostate and neck of the bladder, communicates freely with the hæmorrhoidal plexus posteriorly; it lies between the layers of the recto-vesical fascia, immediately above the vesiculæ seminales, and when its veins are ruptured or lacerated, their orifices remain open, frequently producing troublesome hæmorrhage; they are also invariably dilated in old persons, particularly in those suffering from obstructive diseases of the urinary passages, and in such cases may project, like hæmorrhoids, into the vesical cavity, or they may contain small calcareous bodies (phleboliths). The blood is conveyed from this plexus to the internal iliac, by two branches called the proper vesical veins.

9. Vaginal Plexus consists of a series of loops surrounding the vagina, and receiving numerous branches from the spongy structure of the part, as well as from the submucous plexus, which is largely developed inferiorly and laterally; it communicates in front with the vesical, and behind with the hæmorrhoidal plexuses; and two branches likewise convey its blood into the internal iliac. A case is on record in which death was caused by copious hæmorrhage from the vaginal veins, which had become ruptured during coition.

10. Uterine Plexus.—A complicated interlacement of venous branches, situated on the sides of the uterus, and receiving the blood from the transverse uterine sinuses, which is also conveyed into the internal iliac by two branches. The venous organization of the uterus undergoes a remarkable augmentation during pregnancy, and hence a gravid uterus should be selected for the examination of its veins, when they will be observed to communicate freely with both the ovarian and the hæmorrhoidal veins.

COMMON ILIAC VEINS

Are two in number,—right and left, commencing opposite the sacro-iliac symphysis, on either side, and terminating at the upper third of the body of the fifth lumbar vertebra, on the right side, where they unite to form the inferior cava; the left, lies to the internal side of its corresponding artery, for its entire course, crosses the body of the fifth lumbar vertebra, anterior vaginal ligament, and middle sacral artery, and is covered by the peritonæum, commencement of the rectum, ureter, and near its termination by the right common iliac artery; the right, on the other hand, lies behind its artery, but is slightly internal to it below, and external above. The common iliacs do not, as a general rule, receive collateral

branches, with the exception of the middle sacral vein, which opens into the left; but we have occasionally seen the ilio-lumbar veins terminating in them, on both sides..

INFERIOR CAVA

Is formed by the confluence of the common iliac veins on the right side and upper third of the body of the fifth lumbar vertebra, and ascends at first vertically, but having reached a point corresponding to the third lumbar vertebra, it curves a little towards the right side, and enters a groove in the posterior thick edge of the liver; it then passes through the caval opening in the diaphragm, into the pericardium, and, turning towards the mesial line, terminates in the posterior and inferior angle of the right auricle.

Relative Anatomy.—It lies on the vertebræ, intervertebral substance, anterior vaginal ligament, and when distended, on the anterior margin of the psoas, and sympathetic nerve, right renal artery, right crus of diaphragm, and right phrenic artery; and it is covered by the right common iliac, and right spermatic arteries, by the mesentery, and small intestines, by the inferior transverse portion of the duodenum, head of pancreas, vena portæ, superior transverse portion of duodenum, and by the lobulus dexter of the liver; it is a little constricted as it passes through the quadrilateral tendinous diaphragmatic opening, but on entering the pericardium it again enlarges; it diminishes a second time as it enters the auricle (see ANATOMY of DIAPHRAGM). We have seen this vein diminished to the size of a crowquill, in a case of cirrhosis of the liver, while the first, second, and third lumbar, with the three inferior intercostal, and the internal Rachidian veins, were enormously enlarged, and communicated with the vena azygos, which equalled the normal cava in diameter, and presented near its termination a dilatation as large as an egg, which was buried in the right lung. Here, the azygos evidently took up the function of the inferior cava.

COLLATERAL BRANCHES.—1. Lumbar, 2. Right Spermatic, 3. Renal, 4. Venæ Cavæ Hepaticæ, and 5. Phrenic.

1. LUMBAR VEINS—These will be described with the RACHIDIAN SYSTEM.

2. SPERMATIC VEINS.—Each vessel commences by a number of small branches, which pierce the inner side of the the tunica albuginea, and unite with the veins of the epididymis, to form five or six trunks, which lie in front of the vas deferens, and which are particularly prone to enlargement (cirsocele) near the external abdominal ring. As they ascend they communicate freely with the dorsal veins of the penis, and internal and external pudic veins, and then

wind outwards through the inguinal canal, where they unite, to form either a single or a double trunk, that leaves the vas deferens at the interual ring, aud running upwards and inwards, over the psoas muscle, the right opens into the ascending cava, while the left, terminates in the left renal vein. The spermatic veins form a very intricate plexus, particularly on the left side, as they lie on the psoas muscle (corpus pampiniforme), and while the right runs behind the last coil of the ileum, the left passes behind the sigmoid flexure in its ascent, which principally accounts for the greater frequency of varicocele on this side. The coats of these veins are exceedingly thin, resembling those of the lymphatics, and they are also destitute of valves.

3. Renal, or Emulgent Veins.—Emerge from the hilus of the kiduey, the left crossing the abdominal aorta, behind the inferior transverse portion of the duodenum, and the right lying in front of the right renal artery, and also behind the duodenum, but both terminate in the cava. The suprarenal likewise, consisting of three branches, open into the same vessel.

4. Hepatic Veins.—The radicles forming these veins commence in the centre of the lobule (intralobular vein), which terminates in the sublobular; by the union of the latter, the hepatic veins are formed, consisting of from three to five trunks, which are situated at the posterior thick edge of the liver, between the layers of the coronary ligament, and having received the obliterated ductus venosus, they open separately into the cava.

5. The Phrenic Veins.—Do not present any peculiarity, being merely the accompanying branches of the phrenic arteries.

The inferior veua cava, is by far the largest venous trunk in the whole body, and receives not only the branches we have enumerated above, but likewise offsets from many others, to which attention will be drawn when describing the portal and Rachidian systems. In its ascent through the abdominal cavity, the cava presents three remarkable dilatations—one at its commencement, formed by the confluence of the common iliacs, which is triangular in shape; a second, at the openings of the renal veins, which is oval in figure; and still a third, which is nearly spherical in its outline, formed by the reception of the veuæ cavæ hepaticæ.

VEINS OF THE UPPER EXTREMITY.

We will commence the description, with those of the hand, first examining the superficial set up to the axilla, and subsequently those deeper branches which accompany the arteries of the fore-arm and arm.

Veins of the Hand—Are principally found on the dorsal region, being placed in that position in order to obviate the pressure to which they would be constantly subjected were they situated on the palmar aspect. The digital veins consist of long branches running on the sides and posterior aspect of the fingers, and frequently communicating with each other, by plexiform branches, at the metacarpo-phalangeal sulci; those of the opposed surfaces unite, to constitute trunks which open into the dorsal arch, from the extremities of which arise the cephalic, and basilic veins.

Cephalic Vein, commences on the back of the hand by one branch from the thumb, a second from the index finger, and a third from the external extremity of the dorsal venous plexus; it then winds forwards, over the supinator longus tendon, and about the junction of the inferior and middle thirds of the fore-arm, receives a branch formed by radicles from the ball of the thumb; and also another from the median venous plexus, which lies over the annular ligament; as it still continues to ascend, it receives branches from the outer and back part of the fore-arm, and, reaching the bend of the elbow, it lies between the tendon of the biceps and the inner edge of the supinator longus; it then passes upwards, along the outer side of the arm, at first between the biceps and triceps, then in a sulcus between the deltoid and pectoral; it next arches downwards and inwards, inferior to the clavicle, and over the lesser pectoral, and, piercing the costo-coraco-clavicular ligament, opens into the axillary vein, immediately prior to its termination, having first received a branch from the external jugular, which passes sometimes over, or sometimes under, the clavicle to join it; the cephalic resembles in a great measure the saphena in the lower extremity.

Basilic Vein, arises by a large branch from the internal extremity of the dorsal venous arch, of which it appears the more direct efferent vessel, and a twig from the little finger (vena Salvatella); it then winds forwards over the ulnar extensor, and about the middle of the fore-arm is joined by the cutaneous ulnar vein; next ascending over the cutaneous aspect of the pronator radii teres, and running on the inner side of the arm, it pierces the brachial fascia, and terminates by joining one of the venæ comites of the brachial, to constitute the common brachial vein.

Median Vein, commences from a plexus situated over the annular ligament; it ascends a little to the outer side of the middle of the fore-arm, perforates the fascia about an inch below the flexure of the joint, and terminates in one of the venæ comites of the brachial, this branch being called the mediana profunda; it also gives off two additional branches—median basilic, which, running upwards and inwards, over the origins of the flexors and pronators, and semi-

lunar fascia of the biceps, which separates it from the brachial artery, joins the basilic vein; and the median cephalic, which passes upwards and outwards, over the external cutaneous nerve, in the fissure between the tendon of the biceps and the supinator longus, and unites with the cephalic vein. It must, however, be observed that the last-mentioned veins are by no means regular in size, number, or arrangement, as they frequently differ on the opposite sides of the same subject, so that in the foregoing description we have merely indicated their more usual course. In their whole extent, they are situated between the layers of the superficial fascia.

The Deep Veins of the Fore-arm are, the radial, ulnar, and interosseal, which, being usually two for each arterial vessel, follow exactly their course and termination.

The Brachial Veins, are also double, but at the junction of the upper and middle third of the artery they generally unite with the basilic, to form a single trunk. We say that the former unite with the latter, because the resulting vein is in the direct course of the basilic, and lies internal to the brachial artery; but sometimes, the three branches may remain separate, even to the point where the vessels are supported by the subscapular tendon.

Axillary Vein, is a large trunk, forming the direct continuation of the brachial; it commences at the lower edge of the latissimus dorsi and teres major tendons; and passing upwards, forwards, and inwards, in an arched direction, reaches at the lower border of the first rib, where it terminates in the subclavian. Below, or in its first stage, it lies in front of the axillary artery; in the second it is still anterior, but a little internal to it; and above, or in the third, anterior and internal, and also a little inferior to it; as it lies beneath the clavicle, a process of the ligamentum bicorne is prolonged on it, this tubule having a tendency to retain the vessel in a patulous condition when divided, insomuch that the tying of the vessel in amputation at the shoulder-joint has been strongly recommended. The internal head of the median, and the communicating branch between the anterior and middle thoracic nerves, separate the vein from the artery, as they lie in close relation to each other.

Collateral Branches.—Circumflex, subscapular, thoracic, and cephalic veins, which open in the vicinity of the tendon of the lesser pectoral, producing at this point a remarkable enlargement called the sinus of the axillary vein. The subscapular is a very large trunk about one inch in length, which commences by an anterior and posterior branch, corresponding in all respects to the divisions of the artery of the same name; the trunk formed by their union opens into the inner side of the axillary vein, anterior to the artery, and also to the internal division of the brachial plexus; above the

lesser pectoral, the axillary vein receives the circumflex, acromial thoracic, muscular branches from the deltoid, and superiorly the cephalic trunk.

VEINS OF THE HEAD AND NECK.

The SUBCLAVIAN VEIN, commences as a continuation of the axillary, at the lower margin of the first rib, and passing almost horizontally inwards, terminates at the sterno-clavicular articulation, by uniting with the internal jugular, to constitute the vena innominata. It lies anterior and inferior to the artery, and being transverse in direction, is compared to a chord subtending the arc of a circle, the latter represented by the artery itself. It is covered by the clavicle, to which it is intimately attached by the deep cervical fascia, and by the clavicular origin of the sterno-mastoid, and rests on the anterior scalenus and subclavian artery, while inferiorly it corresponds to the cone of the pleura and first rib. Both right and left veins are about the same length, and are similar in size.

COLLATERAL BRANCHES.—1. External; and 2. Anterior Jugulars; and sometimes 3, the Posterior jugular; with, occasionally, 4. the Vertebral; and 5, Tranversalis Colli, and Transversalis Humeri.

1. EXTERNAL JUGULAR is formed in the parotid gland, by the superficial temporal veins, which, uniting with the transverse facial, first constitute the temporo-facial, and this again being joined by the internal maxillary, the vessel receives the name of temporo-maxillary; which again uniting with the posterior auricular, at length becomes the external jugular; but sometimes the external jugular may commence by an arched branch, which connects it with the internal jugular, and this then receives the veins before mentioned. The vein, when fully formed lies at first beneath the fascia, but soon pierces it, and becomes superficial to it; then covered only by the platysma, it crosses the surface of the sterno-mastoid, and passes downwards, backwards, and outwards, as far as the posterior inferior triangle of the neck, where it terminates, by again piercing the fascia, and opening into the subclavian vein. The external jugular has two valves,—one as it crosses the sterno-mastoid, and the second where it terminates; and in this latter situation a dilatation invariably occurs, always augmented in cases where obstructive disease of the heart or lungs is present; these valves are, however, merely rudimentary. This vein sometimes may be totally absent, sometimes double, or sometimes so exceedingly small as scarcely to be capable of demonstration.

COLLATERAL BRANCHES.—Temporal, transverse facial, middle temporal or internal maxillary, posterior auricular, facial, transversalis colli, transversalis humeri, and cephalic.

TEMPORAL VEIN, or TEMPORO-FACIAL, commences by superficial, deep, and middle branches. The superficial, is formed by the temporo-frontal and temporo-occipital plexuses, which uniting, produce a trunk that passes downwards, over the horizontal root of the zygoma, and is joined by the transverse facial vein; it pours its blood into the external jugular vein.

MIDDLE TEMPORAL, commences by the confluence of the palpebral and orbital veins, and passing backwards, at first between the two layers of the temporal aponeurosis, but soon becoming deeper, lies between the fascia and muscle: it now runs downwards and backwards, and, piercing the fascia from within outwards, opens into the temporal trunk, anterior to the meatus auditorius externus. Another and deeper branch, which may be called the internal maxillary, is formed by the union of the following:—venæ comites of the middle meningeal artery, inferior dental, deep masseteric, pterygoid, deep temporal, and transverse facial; the combined trunk of all these has likewise a similar termination.

TRANSVERSE FACIAL, commences from the masseteric plexus, and passes backwards, sometimes single or sometimes double, above Steno's duct, and pours its blood into the temporal vein.

POSTERIOR AURICULAR, takes its origin from a series of radicles on the mastoid process of the temporal bone; it passes forwards, through the parotid gland, and receiving several communicating twigs in that region, unites with the temporo-maxillary, to form the external jugular vein.

2. ANTERIOR JUGULAR VEIN commences in the suprahyoid region, in a variety of modes, either from the inferior labial, or submental, or even from the facial vein itself, or from all its combinations; or, lastly, by branches of communication with the deep, or the external, jugular; it descends in the substance of the deep cervical fascia, internal to the anterior margin of the sterno-mastoid, and over the sterno-hyoid muscle, and then reaching the upper margin of the sternum, it bends outwards behind the inferior attachments of the sterno-mastoid, and opens into the subclavian, internal to the entrance of the external jugular, or sometimes in common with it. During its course it receives several communicating branches from the internal and external jugular; and immediately above the sternum a transverse branch unites those of opposite sides; this cross branch receives small twigs from the descending thyroid veins above, while a branch, that is always large in the lactating female, joins it from the thorax below. This vein is frequently absent, or may exist on one side only, and it is always inversely proportioned in size to the external jugular.

3. POSTERIOR JUGULAR VEIN commences in the occipito-atlantoid

space, by a branch from the occipital, and vertebral, and is frequently formed by the small vein which escapes through the posterior condyloid foramen; it passes at first downwards and outwards, to emerge from that space, and then runs downwards and inwards, to communicate with that of the opposite side, beneath the spinous process of the axis; curving now downwards and outwards, between the complexus and semispinalis colli, and covered by the splenius, it reaches the root of the neck, between the transverse process of the seventh cervical vertebra and the upper margin of the first rib, and opens into the posterior part of the subclavian, or vena innominata; we have also seen it joining the external jugular. In its course it receives cross branches from the vertebral, and the supraspinous venous plexus, as well as from the muscles of the neck, and its development is always inversely proportioned to that of the vertebral veins; it also forms a part of the posterior external Rachidian system.

INTERNAL JUGULAR VEIN

Commences in the foramen lacerum posterius, by the union of the inferior petrosal and the lateral sinuses; and descending, at first on the outer side of the internal, and then on that of the common carotid arteries, unites at the sterno-clavicular articulation with the subclavian, to form the vena innominata; while in the foramen lacerum, it presents an enlargement called the gulf of the jugular, and opposite the cornu of the os hyoides a second dilatation occurs, where the following veins join the trunk:—Facial, lingual, occipital, ascending pharyngeal, superior thyroid, and transverse branches from the thyroid body, as well as communicating twigs from the anterior jugular; at its point of termination, another large oblong dilatation appears, occasionally twice the size of the original trunk, called the sinus; in its course downwards, the internal jugular lies on the rectus capitis anticus major and longus colli, and is closely attached to the carotid above, only separated by a septum and by the pneumogastric nerve; but inferiorly, it diverges from the artery to a greater extent on the right than on the left side; in the former instance, forming the outer boundary of a triangular space, through which the vagus passes in its course to the thorax.

Collateral Branches.—Facial, lingual, thyroid, occipital, and pharyngeal, with various communicating branches from the several parts of the neck.

1. Facial Vein, commences in the frontal region, and descending by the side of the root of the nose, is united to its fellow by a transverse branch; it then passes downwards and backwards, and receiving the

nasal and subfrontal branches, is now called the angular vein ; it is next joined by branches from the eyelids, and runs obliquely downwards, beneath the zygomatic muscles, and behind the facial artery ; at the anterior edge of the masseter, it obliquely crosses the ramus of the jaw, and is received into a groove in the posterior edge of the submaxillary gland ; it then curves downwards and backwards, and divides into two branches, one of which joins the external, and the other the internal, jugular vein. In its course, it receives the great alveolar vein, which commences immediately behind the jugal ridge of the superior maxillary bone, by the union of the Vidian, superior palatine, spheno-palatine, and still farther forwards, the superior dental and infra-orbital veins. The facial, thus increased in size to nearly double its original diameter, also receives the masseteric, nasal, coronary, and labial branches ; and while in the neck, the glandular, palatine, submental, and tonsillary.

2. Lingual Veins, consist of a dorsal plexus, situated between the mucous membrane and the muscular tissue of the tongue ; these unite to form on the base of the tongue a dorsal trunk, which accompanies the lingual nerve, and terminates on each side in the facial or pharyngeal veins ; the inferior or ranine trunks, which are seen lying longitudinally on the under surface of the tongue, forming an eminence beneath the mucous membrane, join the lingual venous trunks, which are two in number, and which accompany the artery of that name, to terminate either in the internal jugular, or in the facial vein ; or they may form a common trunk with the thyroid and facial before they terminate in the jugular.

3. Thyroid Veins.—*The superior transverse* commences by branches corresponding to the divisions of the superior thyroid arteries, and receives also the efferent branches from the larynx ; it passes backwards, over the external and internal carotids, and pneumogastric nerves, and terminates in the internal jugular vein ; we have repeatedly seen it uniting with the lingual and facial, but have never observed it terminating in either the external or anterior jugular. *Inferior transverse*, commences in the lateral lobe of the thyroid body, at the junction of its middle and inferior thirds, and also receives branches from the larynx, trachea, and œsophagus ; it passes downwards, backwards, and outwards, over the common carotid, and terminates in the internal jugular ; this branch is frequently absent.

4. Occipital Vein, commences in the dense skin of the scalp by long and tortuous branches ; these coalescing form a trunk, sometimes double, which follows the course of the occipital artery, and terminates in the internal, or rarely in the external jugular ; as this trunk lies on the superior oblique it receives the mastoid vein, which maintains a free communication with the lateral sinus.

5. Pharyngeal Vein, is formed by a superficial and a deep plexus, the former lying between the muscles and their fascial envelope, while the latter is situated beneath the mucous layer; they unite to form a trunk, which is exceedingly variable as to its mode of termination, for it may open either into the internal jugular, or into the facial, lingual, or thyroid trunk.

THE DIPLOIC VEINS.

The veins of the diploe may be examined by rasping off the external table of one of the flat cranial bones, when they will be found to consist merely of the lining membrane, surrounded by an osseous sheath of condensed diploe; in the earlier periods of life, they communicate with each other only in the distinct bones; but freely from bone to bone, when the sutures have become obliterated by age. They also communicate with the sinuses and external veins of the scalp, but their peculiarity seems to be, in presenting elevated lips of the lining membrane similar to valves, these being absent in the diploic veins of the general osseous system. It is almost superfluous to state, that each cranial bone, as frontal, parietal, &c. has its separate venous plexus.

BRACHIO-CEPHALIC, OR INNOMINATE VEINS,

Are formed by the confluence of the internal jugular, and subclavian veins of either side, opposite to the sterno-clavicular articulatons, and passing downwards, unite opposite the upper margin of the second rib on the right side, to form the superior cava.

Right Vena Innominata, is about one inch and a half in length, and passes downwards and slightly inwards, to terminate, as already remarked.

Relations.—It lies on the right wall of the anterior mediastinum, pneumogastric nerve, and internal mammary artery; externally, it corresponds to the lung and pleura; internally, to the arteria innominata and commencement of the right subclavian, but separated from the former vessel by the quadrilateral vascular space, containing the pneumogastric and recurrent nerves; and it is covered by the clavicle, first rib, and right margin of the sternum.

Left Vena Innominata, passes obliquely from left to right, is curved, with the concavity directed upwards and backwards, and is about two inches and a half in length.

Relations.—It crosses the left pneumogastric and phrenic nerves, internal mammary artery, left subclavian, thoracic duct, carotid, trachea, arch of the aorta (to which it is also superior), arteria innomi-

nata, and occasionally the right pneumogastric nerve. It is covered by the sternum and the muscles attached to it, and by the thymus gland, and the deep cervical fascia, which binds it to the anterior and superior part of the aorta.

Collateral Branches.—Inferior thyroid, internal mammary, vertebral, phrenic, pericardial, and mediastinal.

1. Inferior Thyroid, commence as two trunks, and descend from the thyroid body in front of the trachea, both usually opening into the vein of the left side; these branches may be united by a cross vessel in front of the trachea, or they may form an intricate network on its anterior part, calculated to impede greatly the operation of tracheotomy.

2. Internal Mammary.—The left internal mammary, also opens into the left vena innominata; the right, terminates in the confluence of the two branches, where they form the cava.

3. Phrenic, Pericardiac, and Mediastinal veins have precisely a similar termination to the preceding.

4. The Vertebral Vein, commences at the transverse process of the atlas, by a branch of communication with the occipital, frequently receiving a small vein, which emerges from the posterior condyloid foramen, thus producing a communication with the lateral sinus; it then descends through successive foramina in the transverse processes of the cervical vertebræ, until it reaches the sixth, where it may divide into two—one, passing in front of the subclavian artery; and the second, behind that vessel, to terminate in the brachio-cephalic veins of their corresponding sides. Although we have these vessels described as opening into the venæ innominatæ, we do not believe that such a termination is the rule, but rather the exception, as we have almost invariably seen them open into the subclavian.

Remarks.—There are many points of difference between the right and left venæ innominatæ: thus the left is the longer, is more oblique, and larger; and it should be borne in mind that in infancy, and sometimes in the female, it is close to the superior edge of the sternum, which should induce a great amount of caution when prolonging the incision for tracheotomy downwards.

VENA CAVA DESCENDENS.

This large trunk, which receives all the veins from the upper half of the body, is about three inches in length, two inches being situated without the pericardium, and one within that sac. It commences at the upper margin of the cartilage of the second rib of the right side, at its junction with the sternum, and, running downwards, inwards, and forwards, terminates at the posterior superior

angle of the right auricle, where the posterior part of its cylinder is continuous with that of the inferior cava. In this course it is curved, the concavity being towards the left side, and as it pierces the fibrous pericardium, a thin process of that membrane is prolonged upwards on its coats; sometimes however, this vessel is replaced by the two venæ innominatæ, opening separately into the auricle.

Relations.—2. *Extra-pericardial:*—It lies on the trachea, and on the pneumogastric nerve of the right side, and is covered by the thymus gland, and in its lower part by the phrenic nerve; it corresponds externally to the phrenic nerve, pleura, and right lung, and internally to the aorta, on which it is moulded. 2. *Intra-pericardial:*—Posteriorly, right bronchus, pulmonary artery and vein; in front, the pericardium, and right auricle with its appendix; and internally, the aorta. In this latter stage, it does not receive any branches.

Collateral Branches.—The vena azygos opens into the posterior and right side of the descending cava, just as the serous layer of the pericardium is about being reflected from the vessel, and occasionally, pericardial branches, right phrenic, internal mammary, mediastinal, thymic, and still more rarely, the right inferior thyroid and vertebral veins, which have been already described with the innominate veins.

Vena Azygos Major, commences in the abdomen, from the ascending lumbar vein, a branch also uniting it with the cava, and sometimes a similar communication existing with the renal, or suprarenal; it ascends through the aortic opening in the diaphragm, on the right side of the thoracic duct, and passing upwards, through the posterior mediastinum, opposite the third dorsal vertebra, it arches forwards, curving over the root of the right lung, but separated from the bronchus by the right division of the vagus nerve, and opens into the posterior and external side of the superior cava, about one inch above the right auricle. This vein has but one valve, which is at its termination in the cava. We have seen it greatly dilated in cirrhosis, combined with contraction of the inferior cava.

Collateral Branches.—Vena azygos minor, intercostals, bronchial, and œsophageal.

1. Vena Azygos Minor.—Irregular as to size and existence; it usually commences from the lumbar loop, in the left lumbar region sometimes communicating with the renal and suprarenal veins, and in one example we saw it receiving a small branch from the inferior mesenteric, and in two, from the spermatic; it ascends through a separate opening in the left crus of the diaphragm, passing upwards as high as the sixth dorsal vertebra, where it crosses the spine behind the aorta and opens into the great azygos. It is styled *Hemi-azygos*, by some anatomists.

2. Intercostals.—See anterior extra-spino Rachidian veins.

3. Bronchial.—Three or four minute twigs, which emerge from the back part of the root of the lung, and open into the azygos.

4. Œsophageal.—Occasionally very numerous, but always remarkable for their very small size. They likewise terminate in the azygos.

SPINO RACHIDIAN SYSTEM.

Spino-Rachidian Veins.—These may be divided into extra- and intra-spinal divisions; and further, each may be described as anterior, and posterior.

Anterior Extraspino-Rachidian Veins, consist of a cervical, dorsal, lumbar, and sacral division. The *cervical*, present four trunks and a uniting plexus; the trunks are the two ascending cervical, and the two vertebral veins, with transverse branches running between them, which receive collateral veins from the bodies of the vertebræ and prævertebral muscles; a second series of transverse branches also unite the ascending cervical vein with the vertebral. The *dorsal*, consists of twelve in number, each commencing by a vein from within the canal, by a second or true intercostal, and by a third which comes forwards from the erector spinæ, all uniting into single trunks, which are thus disposed of. The right nine inferior intercostals, join the vena azygos major, while the three upper unite to form the superior intercostal, which also opens into the curve of the same vein; the left six inferior, join the vena azygos minor, and the fourth and fifth usually cross the spine to open separately into the greater azygos, while the two or three upper, with mediastinal branches, and the phrenic, form the left superior intercostal vein, which crosses the spine opposite the third dorsal vertebra, and likewise terminates in the great azygos. The *lumbar* veins, are five in number, being each formed by a branch from the spinal canal; by a second, from the lumbar mass of muscles; and by a third, from the psoas and quadratus lumborum; these open into a series of loops which surround the transverse processes of the lumbar vertebræ, constituting the ascending lumbar vein that communicates above with the vena azygos major, while from each loop a transverse branch is detached to terminate in the cava, those of the left side running behind the abdominal aorta. In addition to these, the ilio-lumbar vein may also be classed with the lumbar set; it commences by branches corresponding to the division of the artery, and opens into the common iliac; but we have often seen it terminating in the internal iliac vein. The *sacral* set, consist of the lateral and middle sacral veins, the former receiving branches from the sacral canal, levator ani, coccygæus, and pyriformis, while a

series of transverse branches unite them with the middle sacral, when they terminate in the internal iliac; the middle set commence by communicating branches from the lateral and hæmorrhoidal plexus, and ascend to join the left common iliac vein; but we have frequently seen that vessel absent.

The POSTERIOR EXTRASPINAL VEINS, consist of a superficial set, which are subcutaneous; of a second set, which are muscular; and of a deep set, which appear as two longitudinal inflected trunks, lying on either side of the spinous processes of the vertebræ, communicating by cross branches, corresponding to the interspinous spaces, and these again sending ramusculi deeply between the ligamenta subflava, to join the intraspinal vessels. From the outer side of each trunk, branches corresponding in number to the vertebræ, pass outwards and forwards, supported by the laminæ of the spine, towards the transverse processes, and divide into ascending and descending branches, to communicate with those above and below; they join the efferent veins of the spinal canal, in the intervals between the transverse processes.

INTRASPINO-RACHIDIAN VEINS, are divisible into an anterior, and a posterior set; the former, consisting of two longitudinal trunks, lying on the posterior surface of the bodies of the vertebræ, between the margin of the posterior vaginal ligament and the roots of the pedicles, and extending from the foramen magnum to the base of the coccyx, and covered by the dura mater. These trunks are larger in the dorsal and lumbar than in the cervical and sacral regions; and from above downwards present alternate enlargements and constrictions. They are united by a transverse branch, which, passing between the posterior vaginal ligament and the body of the bone, receives one large osseal and several smaller veins, having their origin in the cancellous tissue of the body, while from the external side of each longitudinal trunk an efferent venous branch, corresponding to each vertebra, passes outwards and backwards, to communicate with a similar one from the posterior trunks, which we will now describe.

POSTERIOR INTRASPINO-RACHIDIAN VEINS, also consist of two longitudinal trunks, equal in length to the anterior, lying between the dura mater and the laminæ of the spines, imbedded in a yellowish, soft, fatty tissue; they communicate with each other by transverse plexuses, but these are much more irregular in their arrangement than the anterior; these plexuses receive branches from the posterior external Rachidian veins, producing visible dilatations, where they communicate with the longitudinal trunks; while externally, efferent branches come off, which uniting with similar ones from the anterior, constitute single trunks opening, in the cervical region, into the ver-

tebral; in the dorsal, into the intercostal; in the abdominal, into the lumbar; and in the pelvic, into the lateral sacral veins.

PROPER VEINS of the CORD, form a plexus on the pia mater, which, opposite each nervous root, sends off an efferent branch, that runs outwards, between the anterior and posterior roots, inclosed in the same sheath of dura mater, and opens into the common efferent vein, in the intervertebral foramen. In addition to these, we have often seen, on either side of the cord, a large venous branch pursuing a spiral course, and opposite the tenth or eleventh dorsal vertebra opening into the efferent vein of the right side.

The SPINO-RACHIDIAN VENOUS SYSTEM presents many peculiarities, which exercise a considerable influence on the general venous circulation, by their frequent inosculations; by the absence of valves and the tenuity of their coats, being admirably adapted to fulfil the objects of compensating channels, where particular vessels are obstructed. It communicates with the portal system, through the medium of the middle sacral vein with the hæmorrhoidal; and it is likewise brought into communication with the pulmonary, through the vena azygos, and bronchial veins, on the right side—and the superior intercostal, and bronchial, on the left. With the general venous system it forms endless communications, and it is not astonishing that, in occlusion of the superior or inferior cava, it should undergo a remarkable dilatation. In the skull, the representatives of this system are, the *sinuses*, the superior and inferior longitudinal, straight, and occipital, corresponding to the posterior intraspinal veins, and the cavernous, petrosal, and lateral to the anterior, whilst the circular, transverse sphenoidal, and basilar, correspond to the transverse branches of communication.

PORTAL SYSTEM.

VENA PORTÆ.—This large vein, although very properly considered to represent a separate system, must still be examined in connexion with the veins. Its trunk about four and a half inches in length, is formed on the forepart of the aorta, behind the head of the pancreas, and opposite the upper margin of the second lumbar vertebra, by the confluence of the mesenteric, and splenic veins; it passes upwards, forwards, and towards the right side, between the layers of the lesser omentum, and reaching the liver, divides into a right and left branch, both of which come off at nearly right angles with the original trunk, and enter the transverse fissure, where they follow the ramifications of the hepatic artery, in the substance of the liver.

Relations.—In front, pancreas, superior transverse portion of the duodenum, hepatic artery, and ductus communis choledochus; be-

hind the right crus of the diaphragm, spine, and inferior cava, which it crosses obliquely, separated from it, however, by the foramen of Winslow.

Collateral Branches.—Superior mesenteric, and splenic veins; but the inferior mesènteric opens into the splenic, nearly an inch to the left side of the point where the confluence of the two first forms the vena portæ.

Superior Mesenteric Vein, follows the course of the superior mesenteric artery, receiving at its point of commencement, in fœtal life, the omphalo-meseraic vein, which at that period is ramified on the umbilical vesicle; it likewise receives the ileo-colic, right, and middle colic veins, and from twelve to twenty small branches arising from the small intestines, all which, passing between the layers of the mesentery, open into the left side of this vein.

Inferior Mesenteric Vein, commences by the superior hæmorrhoidal vein, from the plexus of that name; it then receives the sigmoid and left colic branches, and ascends, to open at right angles into the splenic, an inch to the left side of the portal confluence.

Splenic Vein, commences by numerous branches which coalesce at the hilus of the spleen; it then passes almost transversely towards the right, lying posterior and inferior to the pancreas and its corresponding artery, which is tortuous, while the vein is perfectly straight; and having received the inferior mesenteric, pancreatic, and gastric veins, terminates in the porta.

The Vena Portæ, and its branches, are peculiar in being devoid of valves, although a contrary opinion was maintained by Bauer; still, modern authorities agree that they are absent; it is also peculiar in possessing remarkably thick coats, so that when the trunk is divided it remains patulous; again it commences by branches and terminates also in branches, and the blood which it contains ministers to secretion. A case is mentioned by Abernethy, where the porta terminated in the inferior cava, failing to reach the liver; but in that instance the umbilical vein was patulous. Dilatation of the abdominal veins in the vicinity of the umbilicus, compared to the head of Medusa, is recorded by Rokitansky, as being uniformly associated with adult patency of the umbilical vein, and cirrhosis of the liver.

ABSORBENT VESSELS.

Absorption is that function by which structural changes are accomplished in parts of the body itself, the product being carried into the venous system; likewise, by which matters placed in contact either with natural or artificial surfaces are introduced into the system; and also, by which certain parts of organs or structures are re-

moved, for the purpose of modelling the body into original symmetry Absorption is a very general fuuction in all classes of animals; and though Hunter and Monro maintained the opinion that the *lymphatics* constituted the only absorbing channels, still it is now generally admitted, that the veius participate in the action in no small degree, as Magendie and Segalas satisfactorily proved, by a series of well-contrived experiments. It will be sufficient, in a work of this nature, to state that the absorbents have been divided into glands, lymphatic vessels, and lacteals. The *glands* are *conglobate*, oval in shape, of a yellowish-gray colour, indefinite in uumber, size, and situation, depeudiug for their capsule on the prolougatiou over them, of the external tunic of the afferent ducts, and on the condensation of the areolar tissue in the vicinity; but strictly speaking they do not possess any proper ducts. Usually placed in the flexure of joints, each gland varies in size from that of a small pea to that of a large bean; and while a number of colourless small tubcs enter them (vasa afferentia), a second series of tubes, larger and less numerous than the former (vasa efferentia), emerge from them; these are ofteu confounded with collapsed veuous branches, from which, however, they differ in the following respects:—The coats of the lymphatics are thiuner than those of the veins, their valves more regular and numerous, aud they do not unite to form larger trunks, as veins do, but run separately, though often in juxtaposition, towards thc glauds, while they do not communicate so freely. The structure of the lymphatic glands is simple, consisting first of a capsule of a fibrous structure, which, sending sepimeuta into its iuterior, gives it a cellular appcarauce on being divided; the lymphatics euter its substauce and form convoluted tubes, which possibly may also send off lateral cellular diverticula, and theu emerge as thc vasa efferentia; the tubcs, while within thc gland, lose thc arcolar tunic, uothing but a basement layer, supporting a stratum of very opaque cpithelium, constituting their walls; it has likewise been maintained that the glandular lymphatics communicated with the veins aud small arteries (Fohman, Abernethy). The lymphatics commencc on thc surfacc and in the substance of parts, yet their exact origins have never been discovered. The *lacteals*, restrictcd to the small intestines, can be examined with more facility, and with greatcr success. They can be seen arising from the villi, but their arraugemcnt within those parts is still undecided, it being dcscribed as plexiform (Rudolphi), looped (Goodsir), a closcd, dilated ampulla (Henle), and lastly, by open mouths, which is obviously incorrect. The structurc of the lymphatics, and lactcals, may bc inferred from that of the *thoracic duct*, which has, firstly, an arcolar tunic with irregular fibres; secondly, a coat consisting of elastic, circular, and non-stripcd muscular fibre;

and thirdly, a lining membrane composed of serous tissue, consisting of spindle-shaped epithelia, which is thrown into valves resembling those of the veins, but which are more numerous and regular, giving to the lymphatic vessels, when distended, a knotted appearance.

The ABSORBENTS, are divided into superficial and deep sets, and the glands are subject to a similar division, but not in all organs, as their existence, although it may be inferred, has never been proved, in the bones, cuticle, hair, nails, brain, placenta, or umbilical vein.

LYMPHATICS OF THE LOWER EXTREMITIES, should be examined both as glands and vessels, the former being the anterior tibial, poplitæal, and inguinal. The first, or anterior tibial, is a small gland lying on the upper third of the interosseous membrane, or sometimes a little lower down (Hewson); Meckel states that he has seen two in this situation, but Cruikshank has positively declared that he has never observed any glands in the lower extremity below the ham; but we have more than once been enabled to show three or four glands in the course of the anterior tibial veins, when dissecting anasarcous subjects of immature years. The poplitæal glands, are three or four in number, and are situated in the following manner:—One superficial, a second deeper, with a third and fourth on each side of the artery, but in surrounding the vessel we have never seen them exactly opposite, but always on different levels as regarded each other. The inguinal set, are from eight to twelve in number, and consist of superficial and deep, the former again constituting a superior and inferior set; of these, the first, few but large, are parallel to Poupart's ligament, while the second correspond to the course of the internal saphenous vein. The deep, lie in the angle between the pectinæus and adductor longus, on the inside; and the psoas and iliacus, on the outside; while one occupies the femoral ring, to preserve the continuity between the inguinal and external iliac glands.

PELVIC GLANDS.—External iliac, internal iliac, sacral, and pelvic.

The EXTERNAL ILIAC, are five or six in number, all of them being very small, except two, which lie near Poupart's ligament, one anterior, and one external to the artery; but if the gland which occupies the femoral ring be considered as appertaining to this set, the third would lie internal to the vessel; these might possibly become the seat of enlargement, simulating iliac aneurism, but we have not seen them hypertrophied, even in cases where such a result might have been probably anticipated.

The INTERNAL ILIAC.—These lie in the interval between the external and internal aliac arteries, and are often very large in scrofulous children.

The SACRAL GLANDS, lie on the posterior and lateral part of the rectum, between the layers of the meso-rectum, supported by the

sacrum, and we have frequently seen them forming a continuous layer around the gut in cancer recti. Those in the pelvis are the vesical, which lie at the posterior part of the bladder; and in the female, there are also those connected with the vagina and uterus.

The LUMBAR LYMPHATIC GLANDS, are very numerous; the middle set lie on the common iliac arteries, as well as between them, and they also surround the aorta and vena cava; while the lateral, are found in the intertransverse spaces of the vertebræ.

The DEEP LYMPHATIC VESSELS of the LOWER EXTREMITY, are divided into deep, and superficial; the former being, anterior tibial, posterior tibial, and peronæal. The anterior tibial lymphatics, are two in number, one commencing on the outer side of the foot, the other on the dorsum; they unite, forming a trunk that passes upwards, beneath the anterior annular ligament, in the same groove with the anterior tibial vessels, and, passing through the anterior tibial gland, pierces the interosseous membrane to arrive at the poplitæal glands; while the posterior tibial set, receiving the peronæal, ascend in the course of the vessels to reach the same structures.

The SUPERFICIAL LYMPHATICS, commence by an intricate plexus on the dorsum and sole of the foot; they ascend, those in front over the superficial surface of the muscles of the leg, and obliquely cross the upper part of the tibia, to reach a point behind the internal condyle of the femur; they then continue their course in the direction of the sartorius, and open into the inferior superficial inguinal glands, while a few also accompany the posterior saphenous vein, and terminate in the most superficial of the poplitæal glands. In the thigh, the deep lymphatics follow the course of the femoral vessels, and pass through the deep glands, in company with the superficial, that become deep by entering the saphenic opening, in order to reach the iliac glands. The superficial lymphatics of the penis and scrotum, pass outwards, and open into the superior set of superficial inguinal glands; and those of the glutæal region also curve forwards, over the glutæus maximus, glutæus medius, and tensor vaginæ femoris, to open into the same structures, while the abdominal descend to terminate at a similar point. The several lymphatics from the inguinal region enter the pelvis, through the crural ring, internal to the femoral vein, and divide into a descending fasciculus, which enters the internal iliac; and an ascending, which passes through the external iliac set of glands, the former receiving the deep glutæal, vesical, hæmorrhoidal, and deep lymphatics of the penis, as well as those of the uterus and vagina in the female, while plexuses are formed on the external and internal iliac vessels, which, passing through the lumbar glands, terminate in the receptaculum chyli. The lumbar lymphatics also receive those from the testicle, which are divided

into superficial and deep; the former, lying beneath the tunica vaginalis testis; and the latter, commencing in the gland itself, both, however, communicating; they then ascend in the cord, interlacing with the spermatic veins, the course of which they follow, and terminate in the lumbar glands, in common with those of the kidneys and suprarenal capsules, in both of which organs there are also both superficial, and deep lymphatics.

LYMPHATICS of the LIVER.—The glands, are situated in the lesser omentum, behind the pylorus, and are usually of a yellowish black or brown colour. The lymphatic vessels of the liver are first superficial, forming arborescent plexuses beneath the peritonæal tunic on its convex, and concave surfaces, when the former run forwards, between the layers of the falciform ligament, pass through a space behind the ensiform cartilage, and then ascend through the anterior mediastinum, to terminate in the thoracic duct; but the most numerous run backwards, passing between the layers of the respective lateral and coronary ligaments, some perforating the flat portion of the diaphragm posteriorly, to reach the thoracic duct in the thorax, while others pierce the crus, and join the same vessel in the abdomen. The latter, or the lymphatics on the under surface of the liver, having formed a plexus round the gall-bladder, some communicate with the glands in the lesser curvature of the stomach, while others enter those of the lesser omentum. The deep-seated set emerge from the transverse fissure, passing through the glands of the lesser omentum, then through those surrounding the aorta, and vena cava, and ultimately reach the thoracic duct. The lymphatic vessels of the spleen, pancreas, and stomach, being similar to those of other organs, it will be only necessary to state that, after passing through the neighbouring glands, they terminate in the thoracic glands.

INTESTINAL LACTEALS, commence on the villi of the intestines (see ANATOMY of ABDOMEN), and, passing through the mesenteric glands, terminate in the receptaculum chyli; but, in addition to these, there are proper lymphatics for the hollow intestines, some of which pass through the lumbar, others through the mesenteric glands, to reach the commencement of the thoracic duct.

LYMPHATIC GLANDS of the THORAX, consist of those which lie within its walls, and those which lie within its cavity. The first or posterior intercostal are variable in number, lying at the posterior part of the intercostal space, while the second or anterior, lie along the internal mammary vessels, one for each intercostal space; the intrathoracic are, the anterior mediastinal, lying in the inferior part of that space, and the posterior mediastinal, occupying that region in front of the œsophagus and aorta; also pulmonary, which are principally found

in the vicinity of the roots of the lung, being of a dark colour, particularly in the old, from the absorption of carbonaceous matter.

The Lymphatic Vessels, are similarly arranged. The intercostal lymphatics accompany the intercostal blood-vessels, pass through their proper glands, and open into the thoracic duct. The internal mammary lymphatics, commence in the parietes of the abdomen, pass upwards, behind the ensiform cartilage, and then behind the margin of the sternum, and through the glands, in this situation opening on the right side into the lesser, and on the left into the greater thoracic duct.

Lymphatics of the Lungs (see Anatomy of Lungs).

Lymphatics of the Heart, consist of a superficial, and a deep set, some of which open into the thoracic duct, while others join the pulmonary lymphatics.

Lymphatic Glands of the Head, and Face, are found behind the ears, and beneath the insertion of the sternomastoid; in addition to these, the pituitary body, and the glandulæ Pacchioni, have been looked on, by some anatomists, as belonging to the deep lymphatic system. Those of the face, lie on the ramus of the jaw, and on the line of the facial vessels; three or four are also present in the parotid, while a few lie beneath the zygoma, and often a large one on the buccinator.

Lymphatic Vessels of the Head.—The temporal set, pursue the course of the blood-vessels, pass through the parotid chain of glands, and reach the neck, while the occipital set run downwards and backwards, entering the mastoid and occipital glands. The deep lymphatics of the skull, are those of the dura mater, which follow the course of the middle meningeal artery, and escape by the spinous foramen of the sphenoid bone, to terminate in the jugular lymphatics.

Lymphatics of the Brain.—Such contradictory descriptions and delineations have been given by Ruysch, Mascagni, and Fohman, that we are safe in stating that the arrangement of the cerebral lymphatics (if any do exist) is still not ascertained.

Lymphatics of the Face, are divided into superficial and deep; the former commencing on all parts of the face, some running with the frontal, others with the facial arteries, and, passing through the zygomatic, buccal, and submaxillary glands, reach the neck; while the latter or deep, accompany the blood-vessels as temporal, maxillary, nasal, palatine, pharyngeal, &c., and communicate with the deep parotid and cervical glands.

Lymphatic Glands of the Neck.—The superficial run beneath the platysma, and on the external jugular vein, in the posterior inferior triangle of the neck; and two or three smaller lie between the os hyoides and thyroid cartilage; while the deep form a continuous

chain (glandulæ concatenatæ) from the mastoid process to the upper aperture of the thorax, lying on the sheath of the cervical vessels; there are also glands for the trachea, pharynx, and œsophagus.

Cervical Lymphatic Vessels, are constituted by those which descend from the face, also by the tracheal, œsophageal, and pharyngeal, and, having traversed the glands, they terminate on the right side in the right, and on the left in the great, thoracic duct.

Lymphatic Glands of the Upper Extremity.—A few fusiform glands lie in the course of the radial and ulnar arteries, one or two beneath the basilic vein at the bend of the elbow, and a large one, sometimes double, above the internal condyle; several follow the brachial vessels, and in the axilla they are both numerous and large (see Anatomy of Axilla). One is always situated beneath the costo-coraco-clavicular ligament, and we have seen a continuous chain of small glands on the anterior and external edge of the great pectoral muscle.

Lymphatic Vessels of the Upper Extremity.—The superficial commence on the backs of the fingers, and ascend, becoming anterior and posterior on the fore-arm, and divided into groups internal and external, the former ascending behind and before the internal condyle, and uniting, pass through the succession of glands in the course of the brachial vessels to reach the axillary; the latter, or external, passing before and behind the external condyle, and uniting, cross the arm obliquely, to reach the axillary glands, exactly as the internal; one of the external is large, and following the course of the cephalic vein, enters the subclavicular gland; while the deep, follow the course of the vessels to the axilla; and having passed through these glands, terminate in their respective thoracic ducts.

Great Thoracic Duct, commences within the abdomen, in the receptaculum chyli (Pecquet), which receives below, the lymphatics of the lower half of the body; in front, the lacteals, while from its superior part, the duct emanates; it is about two lines wide, and one inch and a quarter long, lying behind the aorta, and on the vertebræ and anterior vaginal ligament; from this, the thoracic duct ascends, between the vena azygos and the aorta, enters the thorax through the aortic opening, ascends in the posterior mediastinum, still related to the above-named vessels; opposite the third or fourth dorsal vertebra, it passes between the œsophagus and aorta, and bending upwards, and to the left side, lies behind the transverse portion of the arch and origin of the left subclavian artery; still continuing to ascend between the carotid and subclavian, but on a plane posterior to both, it passes behind the left vena innominata, resting on the left edge of the œsophagus and vertebral artery, and then curving downwards and outwards, behind the carotid, jugular vein, pneumogastric nerve,

and in front of the inferior thyroid and subclavian arteries, terminates opposite the transverse process of the sixth cervical vertebra, in the left subclavian vein, just at its junction with the jugular. The thoracic duct is about the size of a goose-quill when distended, and is often double for some distance, and then again single ; nor is is it of a uniform size, being large in the lumbar region, small in the dorsal, and large again in the cervical, while its valves are not as numerous as those of other parts of the lymphatic system. It receives all the absorbents of the body, except those of the right side of the head, neck, thorax, and upper extremity, which unite to form a trunk of about one iuch in length, which terminates in the right subclavian vein, at its junctiou with the jugular, and is known as the *right thoracic duct.*

THE END.

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